

COMMODORE 64

CP/M[®]

OPERATING SYSTEM

**USER'S
GUIDE**

USER'S MANUAL STATEMENT

"This equipment generates and uses radio frequency energy and if not installed and used properly, that is, in strict accordance with the manufacturer's instructions, may cause interference to radio and television reception. It has been type tested and found to comply with the limits for a Class B computing device in accordance with the specifications in Subpart J of Part 15 of FCC rules, which are designed to provide reasonable protection against such interference in a residential installation. However, there is no guarantee that interference will not occur in a particular installation. If this equipment does cause interference to radio or television reception, which can be determined by turning the equipment off and on, the user is encouraged to try to correct the interference by one or more of the following measures:

- reorient the receiving antenna
- relocate the computer with respect to the receiver
- move the computer away from the receiver
- plug the computer into a different outlet so that computer and receiver are on different branch circuits.

"If necessary, the user should consult the dealer or an experienced radio/television technician for additional suggestions. The user may find the following booklet prepared by the Federal Communications Commission helpful: 'How to Identify and Resolve Radio-TV Interference Problems.' This booklet is available from the U.S. Government Printing Office, Washington, D.C. 20402, Stock No. 004-000-00345-4."

**COMMODORE 64
CP/M® OPERATING
SYSTEM USER'S
GUIDE**

PRELIMINARY

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CHAPTER

1

INTRODUCTION TO CP/M ON YOUR COMMODORE 64

- Overview of CP/M on Your Commodore 64
- How To Use This Manual
- Digital Research License Information
- Registration Information
- Warranty and Service Information
- Get More out of Your Commodore Computer

Your purchase of the Commodore Z80 add-on microprocessor cartridge puts you in the elite group of owners of a *dual processor home microcomputer*. No one but Commodore—the originator of the home microcomputer—could design and manufacture an inexpensive home or personal computer that accommodates the *two most common microprocessors in the microcomputer industry*:

- the Commodore MOS 6510 (6502 type) microprocessor
- the Z80A microprocessor

The 6510 microprocessor is the main processor on your Commodore 64. The 6510 is a specially designed variation of the widely distributed 6502 microprocessor found in many popular home and office computers. The 6510 runs the same instruction set as the 6502 but includes some special features that make it work more efficiently in your Commodore 64.

It is the 6510 main processor that is active when your Commodore 64 is running in *native mode*. In native mode, your Commodore 64 is controlled by its Commodore 64 Kernal operating system, Screen Editor, and the BASIC V2.2 interpreter. Native mode gives you access to a vast library of Commodore 64 applications packages from Commodore or from one of the many independent Commodore 64 software developers around the world.

When you add your Z80 cartridge to the system and start Digital Research's CP/M® operating system, you open the door to more than **15,000 CP/M-based application programs**. CP/M is the most popular 8-bit operating system and is used for business applications throughout the world.

If you have a special application need, it's very likely that a CP/M package exists to meet it. CP/M applications are available in such areas as:

- financial reporting
- financial analysis
- investment planning
- word processing
- law
- real estate

- farm management
- restaurant management
- data base
- exotic language compilers (PL/I, PASCAL, C)
- and many, many more

1.1 OVERVIEW OF CP/M ON YOUR COMMODORE 64

CP/M on your Commodore 64 can run in a maximum of 48K (1K = 1024 characters) of memory. The rest of memory is occupied by the Commodore 64 Kernal routines that provide input/output support for CP/M.

While you are running CP/M under the Z80 processor, the 6510 main processor acts as an input/output processor. When the 6510 is active, your Commodore 64 is executing in *native mode*. When it's running in native mode, your Commodore 64 "knows" how to handle its keyboard, screen, and peripherals (disks and printer). Rather than duplicate this facility to run under the Z80 processor, CP/M simply calls on the 6510 main processor to perform these tasks.

In addition to CP/M, you get a set of custom utilities that make it easy for you to run CP/M on your Commodore 64. You get:

- The **COPY** utility that formats diskettes in the CP/M format; easily produces backups of CP/M diskettes, even on single-drive systems; and copies the important CP/M system tracks.
- The **CONFIG** utility that makes it easy for you to inform CP/M of changes to your system peripherals, load the Commodore 64 function keys for use under CP/M, and re-define keyboard characters to yield any code you want.
- The **MOVCPM** utility that allows you to create a different sized version of CP/M without the need to learn Z80 Assembler language. MOVCPM relocates *all* of CP/M, including the BOOT and BIOS programs.

You can load anything you like into the **eight Commodore 64 Function Keys**. When CP/M is started, the eight function keys are loaded with the following CP/M commands (<CR> stands for **RETURN**):

F1 Z DIRXCRZ
F2 Z DIR B:XCRZ
F3 Z STAT *.*XCRZ
F4 Z STAT B:.*XCRZ
F5 Z COPYXCRZ
F6 Z CONFIGXCRZ
F7 Z DDTXCRZ
F8 Z DDT

CP/M on your Commodore 64 supports **upper and lower case characters**. You can toggle between upper case only and upper/lower case using the Commodore (**C**) key. For special applications, you can **redefine the codes** returned to your CP/M programs from the keyboard or sent to the screen from your programs.

1.2 HOW TO USE THIS MANUAL

The very first thing to do is to read the *Digital Research License Agreement* in Section 1.3. Next, *fill in and mail* the Digital Research CP/M Registration Card at the end of this manual as soon as possible.

With those tasks accomplished, it's time to start running CP/M on your Commodore 64. **Chapter 2 tells you how to use your Z80 cartridge**. Read this chapter *before* you try to plug it in.

The distribution version of Commodore 64 CP/M assumes that you have a *VIC 1515/1525 printer and a single VIC 1541 disk drive*. If your Commodore 64 is equipped with some other combination, consult **Chapter 3 for information on using your peripherals**.

Chapter 4 is where things really get started. Read this chapter to learn **how to bring up CP/M on your system**. This chapter also tells you about the *Commodore 64 specific CP/M utilities* that you'll need and talks about using the *Commodore 64 keyboard* with CP/M.

IMPORTANT! BE SURE TO MAKE A BACKUP COPY OF YOUR CP/M DISTRIBUTION DISKETTES BEFORE YOU BEGIN PLAYING WITH CP/M. IF YOU DESTROY THESE DISKETTES, YOU LOSE CP/M. SO BE CAREFUL!

ONCE YOU HAVE MADE A COPY OF THE DISTRIBUTION DISKETTES (USE THE FORMAT AND BACKUP FEATURES OF THE COPY UTILITY), PUT THE ORIGINALS IN A COOL, DRY PLACE, AWAY FROM MAGNETIC FIELDS. DON'T USE THEM AGAIN UNLESS YOU ABSOLUTELY HAVE TO (FOR EXAMPLE, IF YOU ACCIDENTALLY DESTROYED ALL OF YOUR OPERATING COPIES)!

The distribution version of CP/M (the one that you get on the distribution diskette) is for a 44K CP/M system. You should use this version if you have the *IEEE* interface cartridge. If you don't, look in **Chapter 4** to **learn how to construct a 48K version** that can take advantage of the additional 4K of RAM available on your system.

Chapter 5 is a reference section which includes descriptions of *all of the CP/M commands and utility programs* that you need to function in the CP/M environment. Chapter 5 shows you how to *execute programs under CP/M* and talks about *CP/M files and file naming conventions*.

Chapter 6 is for those of you who want to get involved in the **technical workings of CP/M on your Commodore 64**. You DO NOT have to know any of this material to use CP/M. If interested, you can look into the first few sections of Chapter 6 to get an idea of *how CP/M is implemented on the Commodore 64 and how CP/M itself is structured*.

The balance of Chapter 6 is for the technically sophisticated user. You can learn about the *BOOT and BIOS programs* written to support CP/M on the Commodore 64 and you can learn how to *cross-call routines between the two processors*. To understand these sections fully, you should have a strong working knowledge of both 6510 (6502) and Z80 Assembler language.

Chapter 7 provides you with the **engineering details of your Z80 cartridge and your Commodore 64**. If you understand computer hardware, you can look here to see how they did it.

This manual is intended to get you started in CP/M. If you want to *explore the depths of the CP/M operating system*, look in your local bookstore for one (or more) of the

many CP/M books published in the last few years. We've listed some of them in the **Bibliography**, Appendix B. Skim the books to see which one you like best.

Likewise, this manual does not provide a tutorial in the use of the Z80 microprocessor. If you're interested in *programming the Z80 in Assembler*, you'll need detailed references. The **Bibliography** contains a list of some of the Z80 books you can find in your bookstore.

1.3 DIGITAL RESEARCH LICENSE INFORMATION

IMPORTANT: Commodore's license with Digital Research requires that each purchaser of the Commodore 64 CP/M system register with Commodore so that accurate records can be maintained of all CP/M users.

Because Digital Research requires this information, we have provided a post card for you to fill out and send in. The serial number of your CP/M system disk is stamped on the labels of the disks you receive with your Z80 cartridge and CP/M information. Please fill out the card and send it to us.

READ THE LICENSE AGREEMENT CAREFULLY.

1.3.1 Digital Research License Agreement

DIGITAL RESEARCH

Box 579, Pacific Grove, California 93950

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GENERAL:

If any of the provisions, or portions thereof, of the Agreement are invalid under any applicable statute or rule of law, they are to that extent to be deemed omitted.

1.4 REGISTRATION INFORMATION

Please fill out the CP/M Registration Card that is enclosed with your Z80 cartridge and CP/M system. Mail the completed card to:

DIGITAL RESEARCH
P.O. Box 579
Pacific Grove, CA 93950

We need the information on the card to provide information on system updates and to inform you of related new products. The serial number of your CP/M system is the number stamped on the label of the CP/M disks.

1.5 WARRANTY

If your unit is defective when you buy it, return it immediately to the original place of purchase. Your dealer will be able to give you the fastest service if you have problems. You can also send your unit directly to Commodore for replacement. The warranty card enclosed in your unit's package lists addresses for service. Be sure to enclose your receipt and a note explaining the problem. See your warranty card for more information.

1.6 GET MORE OUT OF YOUR COMMODORE COMPUTER

Commodore wants you to know that our support for users only starts with your purchase of a Commodore computer. That's why we've created two publications with Commodore information from around the world, and a "two-way" computer information network with valuable input for users in the U.S. and Canada from coast to coast.

In addition, we wholeheartedly encourage and support the growth of Commodore User's Clubs around the world. They are an excellent source of information for every Commodore computer owner, from the beginner to the most advanced. The magazines and network, which are more fully described below, have the most up-to-date information about how to get involved with the User's Club in your area.

Finally, your local Commodore dealer is a useful source of Commodore support and information.

1.6.1 POWER/PLAY: The Home Computer Magazine

For entertainment, learning at home and practical home applications, **POWER/PLAY** is the prime source of information for Commodore home users. From it you will learn where your nearest user clubs are and what they're doing. You'll also learn about software, games, programming techniques, telecommunications, and new products. **POWER/PLAY** is your personal connection to other Commodore users, outside software and hardware developers, and to Commodore itself. Published quarterly, it sells for \$10.00 a year.

1.6.2 COMMODORE: The Microcomputer Magazine

Widely read by educators, businessmen, and students as well as by home computerists, **COMMODORE Magazine** is our main vehicle for sharing information on the more technical use of Commodore systems. Regular departments cover business, science and education, programming tips, and "excerpts from a technical notebook." There are many other features of interest to anyone who uses or is thinking

about purchasing Commodore equipment for business, scientific, or educational applications. **COMMODORE** is the ideal complement to **POWER/PLAY**. *It is published bi-monthly, and subscriptions are \$15.00 a year.*

1.6.3 COMMODORE INFORMATION NETWORK: The Paperless User Magazine

This is the magazine of the future. To supplement and enhance your subscriptions to **POWER/PLAY** and **COMMODORE** magazines, the **COMMODORE INFORMATION NETWORK**—our “paperless magazine”—is available now over the telephone using your Commodore computer and modem.

Join our computer club, get help with a computing problem, “talk” to other Commodore friends, or get up-to-the-minute information on new products, software, and educational resources. Soon you will even be able to save yourself the trouble of typing in the program listings you find in **POWER/PLAY** or **COMMODORE** by downloading direct from the Information Network (a new user service planned for early 1983). The best part is that most of the answers are there even before you ask the questions.

To call our electronic magazine, you need only a modem and a subscription to CompuServe™, one of the nation's largest telecommunications networks. (To make it easy for you, Commodore includes a **FREE** one year subscription to CompuServe™ in each VICMODEM package.)

Just dial your local number for the CompuServe™ data bank and connect your phone to the modem. When the CompuServe™ video text appears on your screen, type G CBM on your computer keyboard. When the **COMMODORE INFORMATION NETWORK** table of contents, or “menu,” appears on your screen, choose from one of our sixteen departments, make yourself comfortable, and enjoy the paperless magazine that other magazines are writing about.

For more information, visit your Commodore dealer or contact CompuServe™ customer service at 800-848-8990 (In Ohio, 614-457-8600).

COMMODORE INFORMATION NETWORK

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CHAPTER 2

SETTING UP YOUR COMMODORE 64

- Unpacking and Connecting the Z80 Cartridge
- Installing the Z80 Cartridge
- Connecting Disk Drives

It's very easy to set up your Commodore 64 to run CP/M. You turn off your computer, plug in the Z80 cartridge, turn on your disks and computer and get started. Follow the directions in this chapter carefully.

REMEMBER: YOU MUST TURN OFF YOUR COMMODORE 64 BEFORE YOU INSERT THE Z80 CARTRIDGE. IF YOU INSERT THE CARTRIDGE WITH THE POWER ON, YOU WILL DESTROY THE CARTRIDGE!!

2.1 UNPACKING AND CONNECTING THE Z80 CARTRIDGE

Before using CP/M on your Commodore 64, you must correctly connect your Commodore 64 to your TV and peripherals. For instructions on connecting your Commodore 64 to your TV, disk, and printer, read the manual that comes with your computer.

When you purchase CP/M for your Commodore 64, you get these items:

1. Z80 cartridge.
2. CP/M system disk.
3. Other disk.
4. User's manual.

Before you can connect your Z80 cartridge, you must know where to connect it. Figure 2.1 shows a diagram of the side and back panel connections for your computer.

Your Commodore 64 has these *side panel* connections:

1. **Power socket.** The free end of the cable from the power supply is attached here to supply power to your Commodore 64.
2. **Power switch.** This turns the power to your Commodore 64 on and off.
3. **Game ports.** These accept a joystick, one or more game controllers, or lightpen equipment. *The lightpen plugs into port 1 only.*

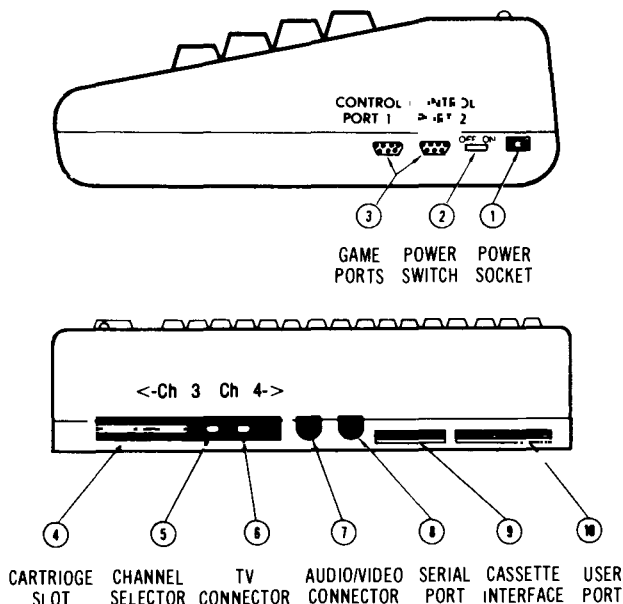


Figure 2.1 Commodore 64 Panel Connections Diagram

Your Commodore 64 has these *back panel connections*:

4. **Cartridge slot.** The rectangular slot to the left accepts program or game cartridges. *This is the connection for your Z80 cartridge.*
5. **Channel selector.** Use this switch to select the TV channel that will display your computer's picture.
6. **TV connector.** This connector supplies the picture and sound to your TV.
7. **Audio & video output.** This connector supplies direct audio (which you connect to your stereo system) and "composite" video (which you connect to a monitor).
8. **Serial port.** This is the connection for your VIC peripherals (1541 drives and 1515/1525 printer). You *must* connect your VIC disk drive to this port and your VIC printer to your VIC disk drive.
9. **Cassette interface.** This is the connection for your DATASSETTE™ recorder.

10. **User port.** This is a port for various interface cartridges such as the VICMODEM or RS-232 communications cartridge.

2.2 INSTALLING THE Z80 CARTRIDGE

Now that you know where your Commodore 64 connections are, you're ready to install your Z80 cartridge. You connect the Z80 cartridge directly to your Commodore 64 if you are using the VIC 1541 disk drive. You connect the Z80 cartridge to an IEEE interface cartridge if you're using the CBM 4040 disk drives or the CBM 4022 printer.

2.2.1 Using the Z80 Cartridge with VIC Peripherals

If you're using *VIC peripherals* like the VIC 1541 disk drives and the VIC 1525 printer, follow these easy steps:

1. **TURN OFF THE POWER TO YOUR COMPUTER!**
2. Install the Z80 cartridge in the cartridge slot marked 4 in the diagram in Figure 2.1.
3. Turn on your computer and you're ready to start using CP/M on your Commodore 64.

REMEMBER! IF YOU INSERT THE Z80 CARTRIDGE WITH THE POWER TO THE COMPUTER TURNED ON, YOU WILL DAMAGE THE CARTRIDGE!

2.2.2 Using the Z80 Cartridge with CBM Series Peripherals

If you're using *CBM series peripherals* like a CBM 4040 disk drive or a CBM 4022 printer, you follow a slightly different procedure for connecting the Z80 cartridge. Remember, you need to use the IEEE interface cartridge if you're using a CBM peripheral.

The IEEE interface cartridge has a connector for other

cartridges (like the Z80 cartridge) and also has a connector for the CBM peripherals. Figure 2.2 shows a diagram of the IEEE cartridge connections.

Follow these easy steps to connect your Z80 cartridge to your Commodore 64 when you're using the IEEE Interface cartridge and CBM series peripherals:

1. **TURN OFF THE POWER TO YOUR COMPUTER!**
2. Install the IEEE interface cartridge in the cartridge slot marked 4 in the diagram in Figure 2.1.
3. Install the Z80 cartridge into the IEEE cartridge slot as shown in the diagram in Figure 2.2.
4. Connect your CBM peripherals to the connector on the IEEE cartridge.
5. Turn on your computer and you're ready to start using CP/M on your Commodore 64.

REMEMBER: IF YOU INSERT THE Z80 CARTRIDGE WITH THE POWER TO THE COMPUTER TURNED ON, YOU WILL DAMAGE THE CARTRIDGE!

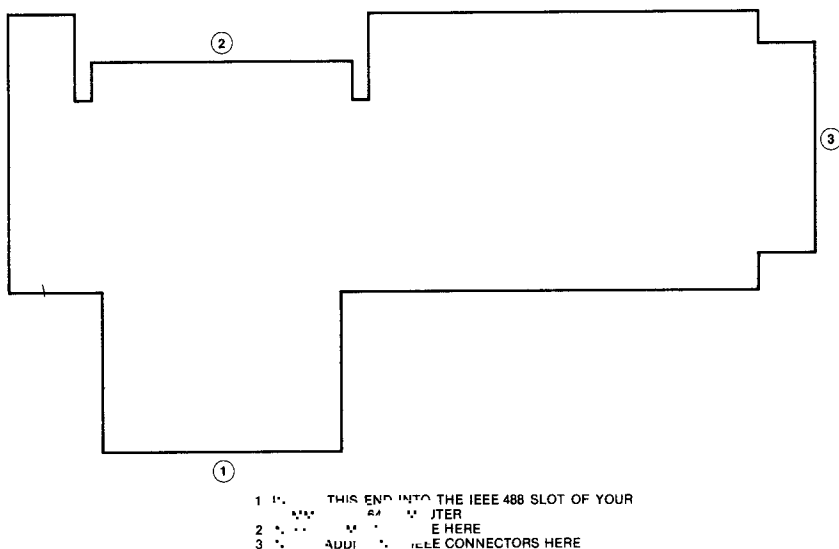


Figure 2.2 IEEE Interface Cartridge Diagram

2.3 CONNECTING DISK DRIVES

The method you use to connect your disk drives depends on the types of drives you use. You can use either a VIC series disk drive (like the 1541) or a CBM series single or dual disk drive (like the 4040) with your Commodore 64.

You don't have to write any special code to use your disk drives under CP/M. The system accesses your disk drives as Drive A and Drive B, regardless of which type of drive you're actually using.

If you use a single disk drive, CP/M uses Drive A and uses a virtual drive for Drive B (CP/M will prompt you to change the physical disk in the drive when you ask for Drive B). If you're using a CBM series dual drive, CP/M uses Drive A and Drive B.

2.3.1 Connecting VIC 1541 Disk Drives

You can use one VIC 1541 disk drive. Like all Commodore peripherals, the VIC 1541 disk drive can be "daisy chained." That is, you can connect your VIC disk drive to a VIC printer.

Connect the single VIC disk drive to the *serial port* (marked 8 in the diagram in Figure 2.1). For full details on connecting a VIC 1541 disk drive to your Commodore 64, see the manual that comes with the drives.

If you're also using a VIC 1525 printer, connect the printer to the connector in the back of your VIC 1541 disk drive.

2.3.2 Connecting CBM Series Disk Drives

When using CBM series peripherals (like the CBM 4040 disk drive or the CBM 4022 printer), you need to connect your peripherals to the IEEE interface cartridge. Figure 2.2 shows a diagram of the IEEE interface cartridge.

You can daisy chain your CBM printer to your CBM disk drive. For more details on connecting your CBM disk drive, see the manual that comes with your IEEE interface cartridge.

CHAPTER

3

USING YOUR COMMODORE 64 PERIPHERALS FROM CP/M

- Printer Interface
- The Commodore 64 Serial Interface
- The IEEE Interface Cartridge
- Daisy Chaining Peripherals
- The Commodore 64 User Port

CP/M, as implemented on your Commodore 64, can access any standard Commodore 64 peripheral (except the RS-232 port and the modem) using standard CP/M device access protocols. This involves calls to the appropriate CP/M BDOS functions. (You can also call the BIOS directly, although this is not recommended.)

The actual peripheral interface drivers reside in the CP/M BIOS. This special BIOS, unique to your Commodore 64, is in two parts. One part executes under the Z80 add-on processor and the other under the 6510 main processor.

Peripheral device access is *set up through a series of parameters* by the Z80 part of the BIOS. The actual device access is carried out by the 6510 part of the BIOS operating in Commodore 64 native mode.

You must configure CP/M—using the CONFIG utility—so that it knows what kind of printer you have and how many disk drives you have. If you change the type of printer or the number of disk drives on the system, you must use the CONFIG utility to inform CP/M of the change.

3.1 PRINTER INTERFACE

CP/M must know what type of printer you have. Generally you will have a VIC 1515, VIC 1525, or CBM 4022 printer. For purposes of the CONFIG utility, the 1515 and 1525 are the same, and the 4022 represents any CBM series printer.

The VIC 1515 and 1525 printers use the standard Commodore 64 serial bus. The 4022 printer (or any other CBM series printer) requires the optional IEEE interface cartridge.

Once you have properly attached the printer to your Commodore 64 and have run the CONFIG utility under CP/M, you can print using programs that run under CP/M or using standard CP/M BDOS calls from Z80 Assembler language programs.

3.2 THE COMMODORE 64 SERIAL INTERFACE

Your Commodore 64 comes standard with a bit serial interface through which you communicate with the Commodore 64 disk drives and printers. Access to the Commodore 64 serial interface is handled automatically under CP/M.

If you attach a nonstandard device to the Commodore 64 bit serial interface, you must prepare code to handle that device. The actual device handling code must execute in Commodore 64 native mode (under the 6510 main processor). Of course, you also need device handling code to run under the Z80, controlling execution of the native mode device-handling routine.

3.3 THE IEEE INTERFACE CARTRIDGE

If you want to connect your Commodore 64 to IEEE bus compatible devices, you can do that using the *IEEE interface cartridge*.

The IEEE interface cartridge plugs into the cartridge slot on the rear of your Commodore 64. The interface cartridge includes a slot for plugging in your Z80 cartridge. (See the instructions that come with your IEEE interface cartridge.)

The interface cartridge allows you to attach Commodore's own IEEE-compatible peripherals. These more capable, more expensive peripherals are usually available only for Commodore's business computers. The IEEE interface cartridge also provides a link to a multitude of IEEE-bus-based products. For example, many industrial and scientific instruments and devices are controlled using the IEEE bus protocols. With the IEEE interface cartridge, your Commodore 64 can control and collect data from these devices.

NOTE: If you do acquire the IEEE interface cartridge, you will have 44K—NOT 48K—available for CP/M. Be sure to generate a 44K version of CP/M before you install the IEEE interface cartridge.

If you are also installing IEEE bus peripherals, especially disk drives, remember to run the CONFIG utility on your 44K CP/M, informing it of your new peripherals.

3.4 DAISY CHAINING PERIPHERALS

The advanced architecture of the standard Commodore 64 serial bus and of the Commodore IEEE serial bus permits peripherals to be linked to one another in a "daisy chain."

Daisy chaining of peripherals means that you need not buy another interface card or connector every time you add a peripheral to your Commodore 64. The peripherals simply connect to each other to be accessed through a single port on your Commodore 64.

You can daisy chain VIC peripherals on the standard Commodore 64 serial bus or CBM series peripherals through the IEEE interface cartridge, as shown in Figure 3.1.

VIC PERIPHERALS SYSTEM

(Uses Standard Commodore 64 Serial Port)

Computer → VIC Disk Drive → VIC Printer

CBM PERIPHERALS SYSTEM

(Requires IEEE Interface Cartridge)

Computer → CBM Dual Disk Drive → CBM Printer

or

Computer → CBM Printer → CBM Dual Disk Drive

Figure 3.1 Daisy Chaining Peripherals.

NOTE: You can also attach the single drive (2031) version of the CBM 4040 disk drive to the IEEE interface cartridge on your Commodore 64.

3.5 THE COMMODORE 64 USER PORT

Your Commodore 64 user port can accommodate some useful optional devices. Most interesting from CP/M are the VICMODEM and the RS-232 communications cartridge.

If you acquire one of these cartridges and you want to access it from CP/M, you must write the processing code for execution in native mode under the 6510 main processor. This is necessary because these cartridges generate non-maskable interrupts which must be handled by the 6510 processor.

You can gain access to special code for handling these cartridges through BIOS65 function codes 7, 8, or 9. (See the discussion of the CP/M BIOS in Chapter 6 for details on using these function codes.)

In designing this code, you should consider receiving a certain number of characters—say 128 or 256—into a shared buffer. When you have received these characters, inform the device you are communicating with that you are not ready to receive data. You can then safely switch control from the 6510 main processor to the Z80, which can do whatever is required with those characters.

For detailed information on programming for the RS-232 port, see the *Commodore 64 Programmer's Reference Manual*.

13.

CHAPTER 4

GETTING STARTED

- Bringing CP/M onto Your Commodore 64
- The COPY Utility
- The CONFIG Utility
- Generating a New CP/M System with SYSGEN

This chapter tells you how to start using CP/M on your Commodore 64. Read it *carefully*. It's very easy to bring CP/M onto your computer, but you should be sure that you understand the information in this chapter before you start CP/M or run any programs under it.

In this chapter you will learn:

- how to load and run your CP/M system
- how to format new disks and make backup copies of your system
- how to use the special Commodore 64 CP/M utilities
- how to generate a new version of CP/M
- how to use the special Commodore 64 keyboard under CP/M

The distribution 44K version of CP/M assumes that you are using the IEEE interface cartridge. If you don't have the IEEE interface cartridge, you can generate a 48K version of CP/M by following the instructions in Section 4.4.

4.1 BRINGING CP/M ONTO YOUR COMMODORE 64

It is easy to bring CP/M onto your Commodore 64. Before you load CP/M, be sure that you've correctly installed your Z80 cartridge and your disk drive(s) and printer. If you haven't done this, read Chapter 2 for installation instructions.

After installing your Z80 cartridge and peripherals, follow the instructions in Section 4.1.1 to load your CP/M system. Once you've loaded CP/M and made copies of the system disks for backup, you're ready to try any of the commands in Chapter 5.

NOTE: Remember to make copies of your CP/M disks before you do any other processing. You need a backup copy of the disks that you purchased.

4.1.1 Starting CP/M

To bring CP/M onto your Commodore 64 system, you start the computer and load the CP/M system. Just follow these easy steps and *make a backup copy of your system disks right after you get CP/M to start for the first time*:

1. Turn on your equipment (peripherals and computer). Your Commodore 64 will print its usual "sign on" message:

```
**** COMMODORE 64 BASIC V2 ****  
64K RAM SYSTEM 38911 BASIC BYTES FREE  
READY.
```

2. Put the disk marked Commodore CP/M®*V.64 into your disk drive. This disk contains your CP/M system.
3. Your Commodore 64 is in native mode. Type the following:

```
LOAD "*",8 <CR>
```

or

```
LOAD "CPM", 8
```

4. Your Commodore 64 reads the disk and answers:

```
SEARCHING FOR * (or CPM instead of *)  
LOADING  
READY.
```

5. The Commodore 64 segment of CP/M is now loaded into your computer. To load the Z80 segment and begin executing CP/M, type:

```
RUN <CR>
```

6. Your Commodore 64 now reads the disk again to load the CP/M system into your Z80. While it is loading CP/M, your computer will print a row of 27 asterisks (*) across the top of the screen. When CP/M is loaded, your Commodore 64 will print:

COMMODORE 64 nnK CP/M vers 2.2

Copyright © 1979, Digital Research

Copyright © 1982, Commodore

A>

7. Your CP/M system is now loaded and ready to run. Enter the following CP/M command to get a list of the files on your CP/M disk:

DIR <CR>

CAUTION! BEFORE PROCEEDING, MAKE A BACKUP COPY OF YOUR CP/M DISKS!

4.1.2 Making Copies of Your CP/M System Disk

Now that you've started CP/M, you *must* make backup copies of your system disks. It is bad practice to use the disks that you purchased as your standard operating disks. You could accidentally destroy the disk and then you would not be able to run your CP/M system.

So, *make a backup copy and use the copy as your CP/M system disk*. After you make the backup copy, *store your original disk in a cool, dry place, away from magnetic fields*.

To make your backup copy:

1. Use the COPY utility on your CP/M disk to format a new disk. The COPY utility is discussed in detail in Section 4.2.
2. Then use the COPY utility to copy your CP/M disk to the backup disk. The COPY utility prompts you along the way, depending on the number of drives you're using. Just follow its instructions.
3. Store your original disks in a *safe* place, somewhere cool, dry, and away from magnetic fields.

4.2 THE COPY UTILITY

The COPY utility is a special Commodore 64 CP/M utility that allows you to:

- FORMAT a diskette for use with CP/M.
- Make a BACKUP of a CP/M diskette.
- Copy the CP/M SYSTEM TRACKS from one diskette to another.

You should use this utility to make a backup copy of your CP/M system disks as soon as you get CP/M up and running. Each COPY utility function is described in a separate section below.

To load the COPY utility, enter:

COPY<CR>

CP/M loads the COPY.COM file and writes:

COMMODORE 64 COPY UTILITY 1.0

1. FORMAT DISK
2. BACKUP DISK
3. COPY SYSTEM TRACKS ONLY
4. EXIT

PLEASE CHOOSE FUNCTION (1-4)

You then choose which COPY utility function you want to use and answer the questions that COPY asks.

4.2.1 Formatting a Disk with the COPY Utility

You must *format* a diskette before you can write any information on it. You must format disks that you'll use under CP/M with the COPY utility.

You format disks when:

- You get new disks and you want to prepare them to be used with CP/M.
- You want to *erase all* of the information currently on a disk.

To use the COPY function to format disks, you enter 1 as follows:

```
...COPY utility messages...  
PLEASE CHOOSE FUNCTION (1-4)      1  
FORMAT DISK UTILITY  
INITIALIZES DISK FOR CP/M  
CAUTION! FORMAT ERASES ALL DATA  
PLACE DISK TO BE FORMATTED IN  
DRIVE 0 AND PRESS ENTER  
OR  
PRESS SPACEBAR TO RETURN TO MENU
```

Now, *remove your system disk from the drive* and place the new disk (the one that you want to format) into the drive.

CAUTION! REMEMBER THAT YOU MUST REMOVE YOUR SYSTEM DISK OR ELSE YOU WILL ERASE YOUR SYSTEM DISK!!

COPY now writes formatting information to your disk. Any information on the disk will be erased and all of the tracks are made available for data. No files remain on the disk after you run COPY's FORMAT. COPY writes these messages during the formatting:

```
FORMATTING DISK, PLEASE WAIT...  
FORMAT COMPLETE  
PRESS ANY KEY TO CONTINUE
```

You can now format another disk, copy information to your newly formatted disk, or exit back to CP/M, depending on your answer. If you want to format another disk, you need to insert the disk to be formatted into the drive. If you want to copy information, follow the instructions from COPY. If you're exiting back to CP/M, you should put your CP/M system disk into the drive.

NOTE: Remember that COPY erases all information from the disk when you use the COPY FORMAT option.

4.2.2 Creating a Disk Backup with the COPY Utility

You can also use the COPY utility to make backup copies of an entire diskette. While making a backup copy, COPY uses a master disk and a slave disk. The *master disk* is the disk that you want to make a copy of (the original disk); the *slave disk* is a formatted disk that will be written to (the copy).

If you are using a single-drive system, the COPY utility will prompt you to insert the master or slave disk into the drive. Be careful when making copies of a disk. Keep track of your master disk so that you don't accidentally copy garbage over your information (and erase your master disk in the process).

To use COPY's BACKUP function, enter a 2 in response to the "choose function" message and follow the instructions from COPY:

```
PLEASE CHOOSE FUNCTION (1-4)    2
DISK BACKUP UTILITY
THE ENTIRE MASTER DISK IS
COPIED TO THE SLAVE DISK
INSERT MASTER DISK IN DRIVE 0
PRESS RETURN (OR SPACEBAR FOR MENU)
```

Now insert the disk that you want to copy *from* into the disk drive. If you decide that you don't really want to copy your disk, simply press the **SPACE** bar and COPY returns to its original menu.

Once the master disk is ready, press the **RETURN** key. COPY then reads a number of sectors from the disk into memory and writes:

```
INSERT SLAVE DISK IN DRIVE 0
PRESS RETURN
```

Put the disk you want to copy *to* into the drive and press the carriage return. *Be careful to keep the master and slave disks in order.*

COPY now writes the information from memory onto the

slave disk and then asks that the master disk be replaced in the drive. This alternating master/slave disk placement will continue until the entire master disk is copied onto the slave disk. At that time, COPY returns to its main menu.

4.2.3 Copying the System Tracks with the COPY Utility

You can copy the CP/M system tracks to another disk through the COPY system track copy function. This function copies only the system tracks, not any other information, from a master disk to a slave disk.

You need the CP/M system tracks on any disk from which you intend to "warm start" CP/M (start CP/M without having to reinsert the system disk). You may want to copy the system tracks to a disk containing a program that you will run often. That way, when you hit a **CTRL** -C to warm start CP/M, you don't have to replace the disk with your system disk.

To copy the system tracks using COPY, enter 3 for your selection from COPY's main menu. Then follow the instructions:

```
PLEASE CHOOSE FUNCTION (1-4)    3
SYSTEM TRACK COPY UTILITY
COPIES SYSTEM TRACKS FROM MASTER DISK
TO SLAVE DISK
INSERT MASTER DISK IN DRIVE 0
PRESS RETURN (OR SPACEBAR FOR MENU)
```

The disk with the COPY utility contains the CP/M system tracks (otherwise, you wouldn't have been able to start your system). Simply press the **RETURN** key or, if you really don't want to make a copy, press the **SPACE** bar.

When you press the **RETURN** key, COPY reads the system tracks into memory and then writes:

```
INSERT SLAVE DISK IN DRIVE 0
PRESS RETURN
```


Remove the master disk from the drive and insert the disk on which you want the system tracks copied into the drive. When you press the **RETURN** key, COPY will write the CP/M system tracks (tracks 0 and 1) to the disk in the drive. After the system tracks are written, COPY returns to its main menu.

4.3 THE CONFIG UTILITY

You use the Commodore CP/M CONFIG utility to *change* the current I/O configuration for your CP/M system. Commodore provides the CONFIG utility so that you can add peripherals to your CP/M system quickly and easily.

CP/M needs to know what peripherals you're using. For example, if you're using only a single disk drive, CP/M will prompt you to change the diskette in the drive when you log to another disk. If you're using two drives, a properly configured CP/M will simply use the second physical drive.

NOTE: You CANNOT mix VIC (serial) peripherals and CBM (IEEE interface) peripherals on the same system.

Each of the CONFIG changes is described in a separate section below. To use the CONFIG utility, you enter:

CONFIG <CR>

CP/M then loads the file called CONFIG.COM and writes:

COMMODORE 64 I/O CONFIGURATION UTILITY

THE CURRENT I/O ASSIGNMENTS ARE:

NUMBER OF DRIVES: 1

PRINTER TYPE: 1515

INITIAL CAPS MODE: ON

DO YOU WISH TO:

1. CHANGE NUMBER OF DISK DRIVES
2. CHANGE PRINTER TYPE
3. CHANGE INITIAL CAPS MODE

4. CHANGE FUNCTION KEY ASSIGNMENTS
5. CHANGE KEY CODES
6. SAVE CURRENT I/O SETUP ON DISK
7. RETURN TO CP/M

PLEASE ENTER SELECTION (1-7)

You simply select the type of change that you want to make and answer the questions that CONFIG asks. CONFIG makes all the necessary changes to your CP/M system, for both the Commodore 64 native code and the Z80 code. Adding or changing peripherals to your Commodore 64 CP/M system is as easy as running CONFIG and answering the questions.

4.3.1 Using CONFIG to Change the Number of Disk Drives

The CP/M system that you receive assumes that you are using a single disk drive. You may actually have the CBM 4040 dual disk drives. CONFIG toggles back and forth between one and two disk drives.

To change the number of drives, you run CONFIG like this:

```
CONFIG<CR>
```

when the CONFIG Messages are printed, choose selection 1.

CONFIG then processes your answer and changes the number of drives available to CP/M. If you originally had one disk drive, CONFIG prints:

```
COMMODORE 64 I/O CONFIGURATION UTILITY
```

```
THE CURRENT I/O ASSIGNMENTS ARE:
```

```
NUMBER OF DRIVES: 2
```

```
PRINTER TYPE: 1515
```

```
INITIAL CAPS MODE: ON
```

```
DO YOU WISH TO:
```

rest of CONFIG messages...

PLEASE ENTER SELECTION (1-7)

If you had *two* disk drives when you started CONFIG, you will see this for the number of drives:

NUMBER OF DRIVES: 1

4.3.2 Using CONFIG to Change the Printer Type

Your original CP/M system assumes that you will be using a VIC 1515 or (1525) printer. You may want to add a CBM 4022 (or other CBM) printer. CONFIG toggles back and forth between 1515 and 4022 printer types.

To change the printer type, you run CONFIG like this:

CONFIG<CR>

when the CONFIG Messages are printed, choose selection 2.

CONFIG then processes your answer and changes the printer type. If you originally had a VIC 1515 printer, CONFIG prints:

COMMODORE 64 I/O CONFIGURATION UTILITY

THE CURRENT I/O ASSIGNMENTS ARE:

NUMBER OF DRIVES: 1

PRINTER TYPE: 4022

INITIAL CAPS MODE: ON

DO YOU WISH TO:

rest of CONFIG messages...

PLEASE ENTER SELECTION (1-7)


If you had a CBM 4022 printer when you started CONFIG, you get this for the printer type:

PRINTER TYPE: 1515

4.3.3 Using CONFIG to Change the Initial Caps Mode

Your original CP/M system assumes that you will be using the all caps mode (all upper case letters when you press the

keys). CONFIG toggles back and forth between initial caps ON and OFF.

With initial caps ON, you get only upper case letters. With initial caps OFF, you get upper and lower case letters. Remember that you can also toggle between caps ON and OFF at any time by pressing the  key.

To change the initial caps mode, you run CONFIG like this:

```
CONFIG<CR>
```

when the CONFIG Messages are printed, choose selection 3.

CONFIG then processes your answer and changes the printer type. If you originally had initial caps ON, CONFIG prints:

```
COMMODORE 64 I/O CONFIGURATION UTILITY
```

```
THE CURRENT I/O ASSIGNMENTS ARE:
```

```
NUMBER OF DRIVES: 1
```

```
PRINTER TYPE: 1515
```

```
INITIAL CAPS MODE: OFF
```

```
DO YOU WISH TO:
```

rest of CONFIG messages...

```
PLEASE ENTER SELECTION (1-7)
```

If you had initial caps OFF when you started CONFIG, you will see this:

```
INITIAL CAPS MODE: OFF
```

4.3.4 Using CONFIG to Change the Function Key Assignments

Your CP/M system loads initial values into the eight Commodore 64 function keys. You can change any of these function key values through CONFIG.

If you save the new I/O configuration to disk, the new values will be loaded into the function keys when you next start CP/M. If you don't save the new configuration to disk,

the function keys are loaded with the new values but are reset to the original values when you next start CP/M.

To change the function key values, you run CONFIG like this:

CONFIG<CR>

when the CONFIG Messages are printed, choose selection 4.

CONFIG then prints:

F1: "DIR"<CR>

F2: "DIR B:"<CR>

F3: "STAT *.*"<CR>

F4: "STAT B:*.*"<CR>

F5: "COPY"<CR>

F6: "CONFIG"<CR>

F7: "DDT"<CR>

F8: "DDT"

ENTER FUNCTION KEY NUMBER (1-8)

TO CHANGE PRESET VALUES.

ENTER 9 TO LEAVE FUNCTION

KEY UTILITY.

To change function key 8 to "PIP<CR>", use CONFIG like this:

ENTER FUNCTION KEY NUMBER (1-8) 8

TYPE IN TEXT USING "RETURN"

OR "CTRL-Z" AS TERMINATOR

F8: "PIP<RETURN KEY>"

ENTER FUNCTION KEY NUMBER (1-8) 9

This changes the value in function key 8 to PIP<CR> while you are using CP/M.

If you end your new key entry with a **CTRL** -Z, instead of a **RETURN** the function key is loaded *without a terminating carriage return*.

If you want to save this value as the initial value for function key 8 for the next time you start CP/M, you must also choose CONFIG selection 6 to save the new I/O configuration to disk. Otherwise, the next time you boot CP/M, your function keys will contain the same initial values as they did this time; any changes you made through CONFIG will be lost.

4.3.5 Using CONFIG to Change the Key Codes

Your CP/M system loads a table containing the hexadecimal values for each of the Commodore 64 keyboard keys. You can change any of these function key values through CONFIG. Appendix D contains a table of ASCII characters, hexadecimal values, and the Commodore 64 keyboard characters.

NOTE: Be careful if you change the alphabetic characters. You may not be able to recover if you change characters that you need to run CP/M programs or commands. If you SAVE the character changes on disk (through CONFIG selection 6), you may have trouble recovering at all.

To change the keyboard key values, you run CONFIG like this:

CONFIG<CR>

when the CONFIG Messages are printed, choose selection 5.

CONFIG then prints:

PRESS KEY TO EXAMINE KEY CODE
TO CHANGE KEY CODE, ENTER DATA IN
HEXADECIMAL AFTER "CHANGE TO"
TO EXIT KEY CODE MODE, TYPE "RETURN"
TWICE AFTER "PRESS KEY"
TO KEEP CURRENT KEY CODE, TYPE
"RETURN" AFTER "CHANGE TO"

PRESS KEY (you press the "Q" key)
IS 51 IN CAPS MODE—CHANGE TO 71

You just changed the capital Q (hexadecimal value 51) to a lower case q (hexadecimal value 71). You won't be able to enter a capital Q unless you use CONFIG to change it back again. If you don't want to make any more changes, just press the **RETURN** key *twice* to return to the CONFIG main menu.

4.3.6 Using CONFIG to Save the New I/O Setup

Once you've made changes to your I/O assignments through CONFIG, you may or may not want to save the new assignments. You will probably want to save the new information if you've changed the disk drive or printer data. You may not want to save the I/O information if you've changed the function key assignments for a special run and don't want the new values to be used the next time you start CP/M.

To save your new I/O assignments to disk, select 6 from the CONFIG menu. CONFIG then writes information to your CP/M system data and the next time you start CP/M, the new information will be used.

Remember, you can make changes that only affect the current CP/M version (the one in memory when you make the changes) if you want some special-purpose alterations. If you don't select CONFIG choice 6, the alterations will not be in effect the next time you load CP/M.

4.4. GENERATING A NEW CP/M SYSTEM WITH SYSGEN

You can generate CP/M on your Commodore 64 to run in any memory size from 20K to 48K. If you are using the standard Commodore 64 serial bus to attach your peripherals—disk and printer—you should use a 48K version of CP/M. If you acquire the IEEE interface cartridge, you must

use a 44K version of CP/M. You may also want to generate a smaller version of CP/M if you need space to load a 6510 routine that you are invoking from a CP/M program.

NOTE: If you don't intend to save the new CP/M on an existing CP/M disk, the first step in generating a new version of CP/M is to **format** a disk. Disk formatting is discussed in detail in Chapter 4 under the **COPY** utility

Once you have the disk formatted for CP/M, you must use the **COPY** utility to copy the **System** tracks from one of your existing CP/M disks to the new disk. This operation places the 6510 loader into its proper place

Once you have properly initialized your disk, you use a series of CP/M utility programs to generate the new version of CP/M and save it on your disk. These utilities are:

- **MOVCPM**
- **SAVE**
- **SYSGEN**

These utilities have a number of options on their use. In the following discussions, we consider only the most frequently used options. A more detailed exploration of all the utility options is found in Chapter 5.

In general, you will be generating either a 44K or a 48K version of CP/M on your Commodore 64. We'll use generating a 48K version as an example. Other versions are generated in exactly the same way but with a different memory size specified.

4.4.1 Relocating CP/M

MOVCPM is a system utility that *relocates* the CP/M operating system to execute in any memory size you specify.

To generate a 48K version of CP/M, you enter:

```
MOVCPM 48 *
```

where:

48 is the memory size

* instructs MOVCPM to leave the relocated CP/M image in memory.

MOVCPM responds with:

```
CONSTRUCTING 48K CP/M vers 2.2  
READY FOR "SYSGEN" OR  
"SAVE 37 CPM48.COM"
```

This is the end of MOVCPM execution. You follow this by running either the SYSGEN or the SAVE utility. Normally, you use the SYSGEN utility. Use the SAVE utility if you want to "patch" the operating system.

NOTE: Your Commodore 64 version of MOVCPM properly adjusts all of the CP/M code, including the BOOT80 and BIOS80 programs. You do NOT have to reassemble these programs and use DDT to patch them into the new version of the operating system as you do on less capable CP/M systems.

Execution of MOVCPM as shown above leaves a copy of the relocated CP/M operating system, including BOOT80, CCP, BDOS, and BIOS80, in the Transient Program Area (TPA) ready to be saved as a file on your disk or written directly to the system tracks. (To learn more about CP/M structure, read Chapter 6.)

If you choose to save a copy, you can SYSGEN it later.

4.4.2 Saving the New System

The SAVE built-in command writes the content of the TPA (in this case, a copy of your newly relocated CP/M) to the specified disk file. The MOVCPM command tells you how many 256-byte pages to save. MOVCPM on your Commodore 64 always tells you to save 37 pages.

To save your relocated version of CP/M, enter:

```
SAVE 37 CPM48.COM
```

This command will write the relocated CP/M to a file named "CPM48.COM". This is a full copy of a 48K version of the CP/M operating system. You can use the saved copy of CP/M in subsequent SYSGEN commands or for direct alteration under DDT.

4.4.3 Using SYSGEN

A version of CP/M that you have saved in a disk file cannot be directly executed. You must first SYSGEN it to the system tracks of a CP/M disk.

SYSGEN *writes the specified version* of the CP/M operating system to the proper locations *on the system tracks* of a CP/M disk. SYSGEN can read a version of the operating system from one of two places:

- The system tracks of diskette.
- A memory image of CP/M loaded into the TPA by the MOVCPM or DDT programs.

If you are using a file containing a SAVED version of CP/M, you must first bring it into memory with the DDT program. In our example, you enter:

```
DDT CPM48.COM
```

then exit from DDT with a G0 command.

If your source for the new version of CP/M is the system tracks of your disk or a memory resident image, you simply enter:

```
SYSGEN
```

and SYSGEN responds with:

```
SOURCE DRIVE NAME  
(OR RETURN TO SKIP)
```

At this point you can specify the drive (A or B) whose system tracks you want read. If you simply hit the **RETURN** key, SYSGEN assumes that a copy of CP/M is already loaded into the TPA.

Whatever way you get the CP/M version loaded into memory, SYSGEN will ask you:

```
DESTINATION DRIVE NAME  
(OR RETURN TO REBOOT)
```

If you respond with a destination drive name (A or B), SYSGEN will write CP/M to the system tracks of that drive.

If you simply hit the **RETURN** key, SYSGEN will reboot from whatever disk is currently in Drive A.

NOTE: If you SYSGEN a CP/M system that is different in size from the one you ran the SYSGEN under, DO NOT try to reboot from a disk containing the new system. This will cause the operating system to crash. Re-insert the disk from which you loaded SYSGEN before you tell it to reboot.

To test a newly SYSGENed version of CP/M, you'll have to start it from native mode on your Commodore 64.

4.5 THE COMMODORE 64 KEYBOARD AND SCREEN WITH CP/M

The Commodore 64 has a full typewriter-style keyboard that behaves as such when you are running CP/M. All of the CP/M **CTRL** shifted control codes operate as they are supposed to. In addition, the **STOP/RUN** key on your Commodore 64 keyboard acts like a **CTRL**-C to produce a warm boot of the CP/M operating system.

In the Commodore 64 version of CP/M, you have the option of using only upper case or both upper and lower case. You *toggle* between them using the Commodore **C** key on the keyboard. You can use the CONFIG utility to tell CP/M to start with upper only or with upper/lower case enabled.

Table 5.3 contains a complete list of the **special CP/M control keys**. These are identical to those defined for CP/M, with a few additional functions taken from your Commodore 64 keyboard.

The Commodore 64 graphics characters and screen color control are not generally available to CP/M. But there is no reason that you can't store values into your Commodore 64 6567 Video Interface Chip's control registers just as you do when running in native mode. To arrive at the proper addresses for the control registers, examine Section 6.1.3, which explains the address mapping between the Z80 and 6510 processors.

The control values that you insert into the registers are the same as those you use in native mode. As an example, suppose you want to use your Commodore 64 graphics character set. Running in native mode, you simply touch the graphics key to switch on the graphics character set. From a CP/M program running under the Z80, you have to control it directly through a store into the appropriate 6567 control register.

The character set selection control register is at

6510 address 53,272 decimal or \$D018 hexadecimal

which converts to the Z80 address base:

Z80 address 49,176 decimal or \$C018 hexadecimal

The character set control register normally contains a \$17. To invoke the graphics character set, you must store a \$15 in the register:

```
MVI A,15H      ;LOAD THE CONTROL VALUE IN A
STA 0C018H     ;STORE $15 IN THE 6567 CONTROL REGISTER
```

Once you've executed this code, the graphics character set is available to you. This operation *does not* change the character codes reaching your CP/M programs from the keyboard—only the display is changed.

You can use the same technique to alter colors, activate Sprites, or even play music through your Commodore 64 6581 Sound Interface Device. If you want to store characters directly into the screen matrix, remember to store Commodore 64 screen codes, *not* ASCII codes.

To use the dynamic features of your Commodore 64 from CP/M, all you have to do is remember that the 6510 addresses for the control registers must be reduced by \$1000 (4096) in your CP/M programs.

CHAPTER 5

CP/M OPERATION

- How to Use This Chapter
- CP/M File Naming Conventions
- Input/Output Hardware Conventions
- CP/M Command Structure
- CP/M Commands

This chapter tells you how to use CP/M on your Commodore 64. It is *not* a detailed lesson on CP/M and its internal workings. It is an introduction to CP/M's conventions and notations, and an introduction to the commands that you can use under CP/M.

If you want detailed information on the internal workings of CP/M, get one of the many fine books listed in Appendix B, the Bibliography. That level of detail is far beyond the scope of this book.

5.1 HOW TO USE THIS CHAPTER

Section 5.2 describes the CP/M file naming conventions. You should follow some reasonable conventions for naming your own files so that you can easily identify their contents.

Section 5.3 discusses the CP/M disk identification conventions. CP/M uses disk A and disk B; your Commodore 64 identifies these disks as disk 0 and disk 1. Section 5.3 also tells you how CP/M differs when you use the VIC 1541 or the CBM 4040 drive.

Section 5.4 describes the CP/M command structure and gives a table of all the CP/M commands that you get with your Commodore 64 CP/M system.

Section 5.5 provides *brief* descriptions of the CP/M commands. If you need more detail, see one or more of the CP/M books listed in Appendix B. Some books are more technical than others, so find the one with the amount of detail you are most comfortable with.

5.2 CP/M FILE NAMING CONVENTIONS

When you are using CP/M on your Commodore 64, you should follow the CP/M file naming conventions. CP/M files have the general format:

[DISK-ID:] FILENAME [.TYPE]

where:

DISK-ID is an optional disk drive identifier (such as A or B) that is needed when you want to use a file not on the currently logged disk.

FILENAME is a one- to eight-character name used to identify your file to CP/M.

TYPE is an optional one- to three-character name used to further identify your file.

Some examples of CP/M filenames are:

A:SAMPLE.BAS	A BASIC sample program stored on the disk on Drive A.
MY.TXT	A text file.
PROGRAM.COM	A program that is executable.
10/25/82.DRY	A diary entry.

CP/M lets you use any alphabetic or numeric character in your file names, as well as some special characters. CP/M reserves a few of the special characters for its own use. You *cannot* use the following characters in a CP/M file name:

< > . , ; : = ? * []

With some software packages, files must be named with specific types, such as SUB for a SUBMIT file or ASM for an Assembly Language source file. Read the information with your software packages to see if you need to follow any naming conventions for that package's files.

Even if you don't have to follow any specific rules in naming your files, you should try to use reasonable naming conventions. In this way, when you get a directory listing (a list of all the files on a disk), you will have some idea of what's in the files.

A file named MORTGAGE.BAS is easier to recognize as the set of source statements for a BASIC program that calculates mortgage rates than a file named X127GY9.123. In other words, it makes sense to name your data files in ways that represent their contents. For example, a file named

01/15/83.DTA could contain the data you collected on January 15, 1983.

Since there are so many CP/M users (over 500,000 to date), certain standard filename types have been adopted. The most commonly used types are shown in Table 5.1.

Table 5.1 Commonly Used CP/M File Types

TYPE	FUNCTION OR CONTENTS
*.ASM	Assembly language source file
.BAK	Backup file
.BAS	BASIC program source file (for some BASIC interpreters like CBASIC)
*.COM	Directly executable transient program
.DAT	Data file
.DOC	Document or text file (required by some word processing packages)
*.HEX	File containing data in hexadecimal format; an Intel HEX format object code file
.INT	Output file from some compilers (CBASIC, JRT PASCAL) that contains intermediate code
*.LIB	Library file
.LST	Program listing (usually output from a language processor like a compiler, interpreter, or assembler)
.PRN	Print file (usually output from an assembler or compiler)
.PRT	Print file (usually output from an interpreter or compiler)

Table 5.1 Commonly Used CP/M File Types

TYPE	FUNCTION OR CONTENTS
.SRC	Source file from the CP/M User's Group
*.SUB	Command file for a SUBMIT run
.SYM	Symbol table file (generated by some compilers, assemblers, and interpreters)
.TEX	Text file (required by some word processors)
.TXT	Text file (required by some word processors)
*.\$\$\$	Either a temporary file or an improperly saved (and unusable) file

NOTE: Those filename types marked with an asterisk (*) must be adopted if you want to use associated software packages or system functions. That is, all CP/M directly executable programs must be named "filename.COM."

5.3 INPUT/OUTPUT HARDWARE CONVENTIONS

CP/M has certain conventions that must be followed when you are reading files from a disk or writing files to a disk.

The first disk drive physically attached to the system is called drive A. The next is drive B. When you are using a single 1541 disk drive, your Commodore 64 CP/M uses a slightly different way of telling which disk is in the drive (this is described in some detail below).

When you begin CP/M, you will be "logged" to drive A and you will see the prompt "A>" on your screen. This means that if you specify a filename in a command and you don't

specify a disk-id before the filename, the disk on drive A will be searched for the file.

You can log to drive B by entering the command:

B:

After entering the **B:** command, any filename that you specify without a disk-id preceding the filename will be read from or written to drive B.

You can change back and forth between drive A and drive B by simply entering the above command. You can tell which drive you're currently accessing by looking at the prompt: it will be **A>** when you're using drive A or **B>** when you're using drive B.

Your Commodore 64 CP/M can use either the VIC 1541 single disk drive or the CBM 4040 dual disk drive. Read the sections below that cover the type of disk drive you have attached to your Commodore 64.

5.3.1 Loading Programs from Disk: Single Drive

It is easy to load and run a CP/M program. You first place the program disk into your disk drive and then enter the filename followed by a carriage return, for example:

```
MYPROG <CR>
```

CP/M then goes to the currently logged disk and looks for the file called MYPROG.COM. If CP/M finds this file, the data in the file are read into the computer's memory and CP/M begins executing those instructions.

If the file is not found on the disk, then CP/M prints the filename followed by a question mark:

```
MYPROG?
```

In such cases, check to see if you have the correct disk in the drive, log to the correct disk, or correct the program name.

For a single-drive system, if you are logged to drive A and your program is on drive B, then remove disk A from the drive, insert disk B, and enter:

B:OTHERPGM <CR>

CP/M will first ask that the appropriate disk be placed in the drive by writing:

INSERT DISK B INTO DRIVE 0, PRESS RETURN

You should put the appropriate disk into the drive and press the **RETURN** key. CP/M will then search the disk for the file called **OTHERPGM.COM**, load the file, and run it.

5.3.2 Loading Programs from Disk: Dual Drive

When using the CBM 4040 dual disk drive, you don't have to physically change the disk in the drive when you want to log to another disk. Since there are two drives, you can insert two disks into the drive: disk A and disk B.

When you enter the **B>** command to log to disk B, CP/M will not ask you to insert a disk into the drive. Instead, CP/M will use the disk already in drive B.

If you want to change which disk is in a drive, you should change the disk and then tell CP/M that a different disk is in the drive by entering a **CTRL -C** command. This makes CP/M read the directory from the disk and keeps you from writing over information that you want to keep.

You must have the Commodore 64 IEEE interface cartridge when you use the CBM 4040 dual disk drive. You cannot plug the dual disk drive into the Commodore 64 without the interface cartridge.

5.4 CP/M COMMAND STRUCTURE

Your Commodore 64 CP/M system includes a Console Command Processor (CCP) through which you interact with CP/M. The CCP reads and interprets the commands you enter at the keyboard.

The CP/M commands are listed in Table 5.2 and described in some detail later in this chapter.

In general, the CP/M commands are of two types:

- *Built-in commands* which are a part of the CCP itself. Being part of the CP/M operating system, built-in commands are included whenever you load CP/M.
- *Transient commands* which are loaded into the Transient Program Area (TPA) from a disk and then executed. Transient commands reside on the disk as COM files.

Table 5.2 CP/M Commands

COMMAND NAME	BUILT-IN (B) or TRANSIENT (T)	COMMAND FUNCTION
<i>pgm-name</i>	T	Load and execute the program stored on the disk as file <i>pgm-name.COM</i> .
<i>x:</i>	B	Change the currently logged disk to disk <i>x</i> .
<i>ASM</i>	T	Load the CP/M assembler and assemble the specified program from the disk.
<i>DDT</i>	T	Load the CP/M debugger (DDT) and begin executing the debugger.
<i>DIR</i>	B	List the filenames in the disk directory.
<i>DUMP</i>	T	Dump the contents of the specified file to the screen in hexadecimal format.
<i>ED</i>	T	Load and execute the CP/M text editor program.
<i>ERA</i>	B	Erase the specified file(s) from the disk.

Table 5.2 (Continued)

COMMAND NAME	BUILT-IN (B) or TRANSIENT (T)	COMMAND FUNCTION
LOAD	T	Produce an executable (COM) file from an assembled (HEX) file.
MOVCPM	T	Recreate the CP/M system for the specified memory size.
PIP	T	Copy specified file(s).
REN	B	Rename the specified file.
SAVE	B	Save the contents of memory as the specified file on the disk.
STAT	T	Provide status information about specified files, no file, or all files, and list the number of available bytes remaining on the disk.
SUBMIT	T	Read the specified file and execute the commands in a batch processing mode.
SYSGEN	T	Create a new CP/M system diskette.
TYPE	B	Type the contents of the specified file onto the screen.
USER	B	Change the currently logged user number to the specified value.
XSUB	T	Allow the entering of data as well as CP/M commands in a SUBMIT file.

In addition to the commands listed in Table 5.2, your CP/M system includes a number of built-in *line editing*

commands. The CP/M line editing commands, shown in Table 5.3, have the general form:

CTRL -x

where:

CTRL means hold down the CONTROL key on your Commodore 64.

x is one of the keys on your Commodore 64 keyboard.

Table 5.3 CP/M Built-in Line Editing Commands

COMMAND	FUNCTION
CTRL -C	Perform a CP/M <i>warm-start</i> .
or RUN/STOP	
CTRL -E	Move to the beginning of the next line.
CTRL -H	Delete one character and erase it from the screen.
or DEL	
CTRL -J	Perform a carriage return and line feed.
CTRL -M	Perform a carriage return.
or RETURN	
CTRL -P	Toggle printer/console output. On first use, send all screen messages to the printer; one next use, send all screen messages to the screen.
CTRL -R	Repeat the current command line.
CTRL -S	Temporarily halt listing of data on the screen. Press any key to continue listing.
CTRL -U	Cancel current command line.
or CTRL -X	
C	Toggle between all upper case and upper/lower case letters. C is the Commodore key.

5.5 CP/M COMMANDS

This section gives you a brief description of the Commodore 64 CP/M commands. It is *not* intended to be a detailed description of how CP/M commands operate, nor does it attempt to describe every possible way you can use the CP/M commands.

If you need to learn how CP/M works or if you need more detail on how the commands work, you should purchase one or more of the excellent CP/M teaching texts on the market. Skim these books and pick those that present the information in a way that you can easily understand.

The following notation is used in describing the CP/M commands:

- *Underlined* words show arguments (parameters) which you replace with your own values.
- **BOLDFACE** keywords must be entered *exactly* as shown.
- A *vertical bar* (|) separates arguments where you may select any one of the list of arguments.
- *Square brackets* ([]) are used to show *optional arguments*. You select any or none of the arguments listed, depending on your needs.
- *Braces* ({ }) show that you *must* choose one of the arguments.

5.5.1 *pgm-name* (Load and Run a CP/M Program)

Format: [*disk-id*:]*filename*<CR>

where:

disk-id is an optional disk identifier.

filename is the name of the file containing the program to be loaded and run. Programs must be stored in files named *filename*.COM.

Description:

CP/M programs are stored in files named *filename*.COM. When you type the name of one of

these program files and hit the carriage return key, CP/M does the following:

1. Searches the currently logged disk or the disk specified by *disk-id* for the program file *filename.COM*.
2. Loads the program file into memory.
3. Begins executing the instructions in the program.

If the file is not found on the disk, CP/M prints a message like this:

FILENAME?

When you get this message, make sure you have the correct disk in the disk drive, that you've spelled the program filename correctly, and that the program is stored in a COM file.

Example 1:

To load and execute your program which is stored in the file MYPROG.COM, enter:

MYPROG <CR>

CP/M searches the currently logged disk for the file MYPROG.COM, loads the file, and begins executing the instructions. If the file is not on the disk, you will see the error message:

MYPROG?

Example 2:

You have a single drive system and are currently logged to disk A. You want to load and run the program XYZ from disk B. Enter the CP/M command:

B:XYZ <CR>

CP/M then responds with:

PLACE DISK B INTO THE DISK DRIVE AND HIT RETURN

Put the appropriate disk into the disk drive and press the **RETURN** key. Then, CP/M searches for the file named XYZ.COM, loads the file, and begins executing its instructions.

5.5.2 x: (Change the Currently Logged Disk)

Format: *disk-id*:

where:

disk-id is the disk identifier

Description:

Under CP/M, you are always "logged" to a disk. You can tell which disk CP/M is using by looking at the prompt message. If it's "A>", you're logged to disk A; if it's "B>", you're logged to disk B.

You can change the logged disk by entering:

DISK-ID:

CP/M then asks you to insert the appropriate disk into the disk drive and hit the carriage return. CP/M remembers which disk you're currently logged to and will request another disk if you ask for a file or program and use the *disk-id* qualifier.

Example:

You have a single drive system and are currently logged to disk A. You want to log to disk B. To do this, you would enter:

B: <CR>

CP/M then writes:

INSERT DISK B INTO DRIVE 0, PRESS RETURN

When you insert the disk into the drive and hit the carriage return, CP/M is logged to that disk. The CP/M prompt will now be:

B>

5.5.3 ASM

Format: **ASM** *filename* [*.parms*]

where:

filename is the name of the file containing the program to be assembled. The file must be named *filename*.ASM.

parms contains up to three characters specifying the drive(s) for the source file, HEX file, and PRN file.

Description:

The ASM command loads and executes the CP/M Assembler which processes 8080 instructions. The CP/M Assembler:

1. Assembles the assembly language statements contained in the file *filename*.ASM.
2. Generates an object file in hexadecimal format and places the object file in *filename*.HEX.
3. Produces a print file in *filename*.PRN.

The *parms* string is an optional character string which tells the assembler where to read and write its files. You can specify up to three characters in *parms*. Each character position has a special meaning:

- Position 1: The source drive for the file containing the assembly language statements.
- Position 2: The destination drive for the object (HEX) file.
- Position 3: The destination drive for the print (PRN) file.

If you specify a "Z" for positions 2 and/or 3, the assembler will not generate a HEX (position 2) or PRN (position 3) file. If you specify an "X" for position 3, the listing will appear on your screen instead of in a file. Table 5.4 lists the ASM error messages.

NOTE: CP/M was written for the Intel 8080 microprocessor. The Z80 processor in your Commodore 64 is compatible with the 8080 processor but offers a much larger instruction set, more internal registers, and other advantages.

If you want to use the full Z80 instruction set, you'll have to get an assembler that recognizes the Z80 instructions.

Table 5.4 ASM Error Messages

ERROR CODE	MEANING
D	Data error. The data element cannot be placed into the specified data area. For example, you cannot put the value 500 in a one-byte area.
E	Expression error. The assembler could not evaluate the expression.
L	Label error. The label is used out of context. This could be a duplicate label.
N	Not implemented. You tried to use a feature that is not implemented, such as using macros.
O	Overflow. The expression is too complicated to evaluate.
P	Phase error. A label's value changed between passes of the assembler.
R	Register error. The value specified as a register does not match the value needed by the op code.
S	Syntax error. The statement contains a syntax error and could not be evaluated.
U	Undefined lable. You used a label which does not exist in the program.
V	Value error. There is an improperly formed operand in the expression.

Examples:

- ASM APROG.BBB Assemble the assembly language program contained in the file B:APROG.ASM and put the object file in B:APROG.HEX and the print file in B:APROG.PRN.
- ASM PGM2.BZZ Assemble the assembly language program contained in the file B:PGM2.ASM. Do not generate either the object (HEX) file or the print (PRN) file.
- ASM PGMFOR.AAX Assemble the assembly language program contained in the file A:PGMFOR.ASM. Put the object file (PGMFOR.HEX) onto Disk A. Print the listing on the screen.

5.5.4 DDT

Format: **DDT** [[*disk-id*:] *filename*[*.type*]]

where:

disk-id is an optional disk identifier.

filename.type is a valid CP/M filename for the file containing the information to be loaded and processed by DDT.

Description:

DDT is the CP/M Dynamic Debugging Tool which you can use to interactively test and debug programs. You can load *any* file into memory using DDT. If you load an executable file, you can directly control its execution from your console.

NOTE: You can also use DDT to look at a file in both ASCII and hexadecimal format.

DDT loads the file into the TPA (Transient Program Area) in memory. You can then use the commands shown in Table 5.5 to operate on the information in the TPA.

You must know 8080 assembly language instructions to use DDT. If you don't know the assembly language instructions, don't try to use DDT. Appendix B gives a list of some of the currently available Z80 assembly language books.

NOTE: DDT recognizes only the subset of Z80 instructions that is identical to the Intel 8080 microprocessor instruction set.

Table 5.5 DDT Commands

COMMAND	MEANING
As	Assemble. Begin entering assembly language instructions at address <i>s</i> .
D[s[,f]]	Display. Display the contents of memory in both hexadecimal and ASCII formats. Begin at address <i>s</i> and end at address <i>f</i> . If you don't specify <i>f</i> , 16 display lines are shown. If you don't specify <i>s</i> , the starting address is the current display address.
Fs,f,c	Fill memory. Fill memory with the hexadecimal byte <i>c</i> . Begin storing the byte <i>c</i> at location <i>s</i> and end at location <i>f</i> . You use the F command to fill a block of memory with one value, for example, all zeros or blanks.
G[s] [,b1[,b2]]	Go. Begin executing the instructions at location <i>s</i> with optional breakpoints at locations <i>b1</i> and

Table 5.5 (Continued)

COMMAND	MEANING
	<i>b2</i> . If you don't specify location <i>s</i> , execution begins at the current address.
H<i>c1,c2</i>	Hexadecimal sum/difference. Add (or subtract, depending on the signs) the hexadecimal constants <i>c1</i> and <i>c2</i> .
I<i>filename.type</i>	Input. Insert the filename <i>filename.type</i> into the default file control block for the TPA. You must use an R command to actually read the file.
L[s[f]]	List. List the assembly language mnemonics beginning at address <i>s</i> and ending at address <i>f</i> . If you don't specify a value for <i>s</i> , the listing begins at the current address. If you don't specify a value for <i>f</i> , 12 lines are listed.
M<i>s,f,d</i>	Move a block of information. Move the contents of a block of memory. Begin moving data from address <i>s</i> and end at address <i>f</i> . Move the information to address <i>d</i> .
R[o]	Read a disk file. Read the file whose filename and type are in the file control block into the program area beginning at offset <i>o</i> . You use an I command to set the file information in the file control block. If you don't specify an offset value, the file is read into memory beginning at address 100H.

Table 5.5 (Continued)

COMMAND	MEANING
Ss	Examine and modify memory values. DDT begins processing at location s. All addresses and their contents are listed. If you hit a carriage return, the contents are not changed. If you want to change the value, enter a new value before you hit the carriage return. To stop the listing, hit a period (.).
T[n]	Trace program execution. DDT traces execution and displays registers and flags for n steps. n may be 1 through 65535. If you don't specify a value for n, DDT executes and traces one statement.
U[n]	Untrace. This performs the same processing as the T command except that the registers and flags are not displayed for each step.
X[r]	Examine and modify CPU registers. The examine command lets you examine and optionally modify the contents of the CPU registers shown in Table 5.6. If you don't specify a value for r, all of the CPU registers are displayed in the format shown in Table 5.7.

Table 5.6 DDT CPU Registers/Status Flags

NAME	MEANING	VALUE
STATUS FLAGS:		
C	Carry flag	0/1
Z	Zero flag	0/1
M	Minus flag	0/1

Table 5.6 (Continued)

NAME	MEANING	VALUE
STATUS FLAGS:		
E	Even parity flag	0/1
I	Interdigit carry	0/1
REGISTERS:		
A	Accumulator	0-FF
B	BC register pair	0-FFFF
D	DE register pair	0-FFFF
H	HL register pair	0-FFFF
S	Stack pointer	0-FFFF
P	Program counter	0-FFFF

Examples:

DDT Loads DDT and waits for you to enter commands.

DDT PROG.COM Loads DDT and reads the file PROG.COM into the TPA (address 100H). DDT then waits for you to enter commands.

Table 5.7 DDT CPU Register/Flag Display Format

CfZfMfEfIf A=bb B=dddd D=dddd H=dddd S=dddd
P=dddd inst

where:

C, Z, M, E, and I are processor status flags shown in Table 5.6

A, B, D, H, S, and P are the registers shown in Table 5.6

f is a 0 or 1 flag value

bb is a byte value (0 through 255)

dddd is a double byte value

inst is the disassembled 8080 instruction at the location addressed by program counter (P)

5.5.5 DIR

Format: **DIR** [*disk-id*:] [*filename.type*]

where:

disk-id is an optional disk identifier.

filename is an optional valid one- to eight-character CP/M filename.

type is a valid one- to three-character CP/M file type. You need to specify a *type* if you use the *filename* parameter.

Description:

You use a **DIR** command to display the directory of files on a certain disk *disk-id*. If you don't supply a *disk-id* parameter, DIR lists the directory of the disk in the drive currently logged to the system.

You can use the CP/M wildcard (* and ?) characters in your *filename* and *type* parameters. These characters are acted upon as follows:

- **question mark (?)**

Use a question mark (?) to represent a *single* character in a filename or type. DIR will use the ? to match on *any* character that occupies that position in the filename or type. For example,

DIR PGM?.COM

will display all files that have the first three characters PGM, any fourth character and the type COM. This format will match only files with names PGMx.COM. It will *not* match PGMxxx.COM.

- **asterisk (*)**

Use an asterisk (*) to represent an *entire* filename or type or the *remainder* of a filename or type. DIR will match on *any* characters in the positions indicated by the *. For example,

DIR PGM*.COM

will display all files that have the first three characters PGM, *regardless of the length of the filename*, and the type COM.

If you use a *disk-id* value, DIR will display only those files on the indicated disk. If you omit the *disk-id* value, DIR displays the files on the currently logged disk.

Examples:

DIR	Display the directory of the currently logged disk. The names of all files on the disk are shown.
DIR B:	Display the directory of Disk B.
DIR B:TEST.COM	Display the directory information for file TEST.COM on Disk B. You can use this form of the DIR command to check whether the file you want is on that disk.
DIR *.BAK	Display the information from the currently logged disk for all files which are of the type BAK.
DIR TEST*.BAK	Display the information from the currently logged disk for all files that are of the type BAK and whose filenames contain the first four characters TEST. This will display the files TEST.BAK, TEST1.BAK, TESTXXX.BAK, TEST1234.BAK, or any other file with the first four characters TEST and type BAK.
DIR TEST??.BAK	Display the information from the currently logged disk for all files that are of type BAK and have a four- to six-character filename beginning with the letters TEST. This will display the files TEST.BAK, TEST1.BAK, or TESTXXX.BAK but will <i>not</i> display the file TEST1234.BAK.

5.5.6 DUMP

Format: **DUMP** [*disk-id*:]*filename.type*

where:

disk-id is an optional disk identifier.

filename is valid CP/M filename of the file whose contents are to be displayed.

type is a valid one- to three-character CP/M file type.

Description:

You use a **DUMP** command to display the contents of a file in hexadecimal format. The file information is shown on the screen.

Examples:

DUMP A:DATA.TST Dump the contents of the DATA.TST file on Drive A to the screen. The file information is shown in hexadecimal format.

DUMP MY.DTA Dump the contents of the MY.DTA file, which is on the currently logged disk, to the screen.

5.5.7 ED

Format: **ED** [*disk-id*:]*filename.type* [[*disk-id2*:] [*filename2.type2*]]

where:

disk-id is an optional disk identifier.

filename is the name of the file containing the data to be edited.

type is a valid CP/M file type for the file containing the data to be edited.

disk-id2 is an optional disk identifier needed when you want the edited file to be written to a disk other than the disk being edited.

filename2 is the name of the output file when you want the edited filename to differ from the original filename.

type2 is the type for the output file when you want the edited file to have a different type than the original file.

Description:

You use the **ED** command to run the CP/M context editor to create or change CP/M source language, data, and text files. ED works on the data in its buffer, using a character pointer to keep track of its current position. Be sure that you understand how to use ED; you could lose your edited file if you're not careful!

If the file exists when you enter the ED command, CP/M opens it and prepares to operate on it. If the file does not exist, CP/M creates a new file with the specified name. CP/M names its temporary file *filename.**** while you are editing the information.

When you are finished editing the file, CP/M changes the name of the original file to *filename.BAK* and writes the edited information to the file named *filename.type* when you tell ED to write the data. If you don't tell ED to write the edited information to the file, you will lose the edited data. You must tell ED *everything*!

If you want to write the edited file to a disk other than the one containing the original file, specify a *disk-id2* parameter.

If the file that you are editing is too large to fit in memory, you must tell CP/M's ED processor when to swap information to its work files. The amount of data that can be processed without swapping depends on the size of your CP/M system. The standard Commodore 64 CP/M system is a 44K version.

You use the control characters shown in table 5.8 and the commands shown in table 5.9 when you are editing a file using ED.

Remember that the CP/M ED editor is not a very complex editor. It works in its buffers, and you must tell it *everything*. After you enter the command that tells ED what file to edit, you must tell ED to read in a specified number of lines from the file. In the same way, after you have finished editing, you must be sure to close the processing with an E command to save your edited data.

NOTE: Some ED commands (F, I, N, and S) when entered in upper case, automatically translate all subsequent lower case entries to upper case. If you enter these commands in lower case (f, i, n, s), the automatic translation to upper case is not done, and data can be entered in both upper and lower case

Table 5.8 CP/M ED Control Characters

CHARACTER	MEANING
CTRL -L	Used as a logical carriage return/line feed within a string.
CTRL -X	Line delete.
CTRL -Z	String terminator/separator.
DELETE	Delete the previous character.

Table 5.9 CP/M ED Commands*

COMMAND	FUNCTION
n:	Move the character pointer to the beginning of line n.
[+/-]n	Move the character pointer up (-) or down (+) n lines and type the line.
nA	Append n lines from the original file <i>filename</i> to the buffer in memory.

Table 5.9 (Continued)

COMMAND	FUNCTION
0A	Append enough lines from the file to half fill the buffer.
#A	Append enough lines from the file to fill the buffer or reach the end of file.
[+/-]B	Move to the top (B) or bottom (-) of the buffer.
[+/-]nC	Move the buffer character pointer forward (+) or backward (-) <i>n</i> characters in the buffer.
[+/-]nD	Delete <i>n</i> characters from the buffer. Delete the characters before (-1) or after (+) the character pointer.
E	End the ED session. Rename the original file to <i>filename</i> .BAK. Close the files and save the new file.
nFstring[^Z]	Find the character string <i>string</i> <i>n</i> times. If you don't supply a value for <i>n</i> , the <i>string</i> is found only once. You use the CTRL -Z (^Z) to end the <i>string</i> when you want to enter another ED command on the same line as the F command. This command performs an automatic translation to upper case. To find a character string that includes lower case letters, use the f form of this command.
H	Save the new (edited) file. Rename the original file to <i>filename</i> .BAK.

Table 5.9 (Continued)

COMMAND	FUNCTION
	Re-edit the file using the new file as the original file. This is the same as entering an E (end edit) command and then running the ED editor again on the newly saved file.
I<CR>	Enter insert mode. You must enter a CTRL -Z (^Z) to end insert mode. When you use an I command, you can enter only upper-case characters. The character pointer is moved to the end of the inserted text when you enter the CTRL -Z. To enter both upper-case and lower-case information, use the I command described below.
Istring(^Z)	Insert the character string <i>string</i> at the position in the buffer pointed to by the character pointer. The CTRL -Z marks the end of the string to be inserted. The character pointer is moved to the end of the inserted string. You can enter only upper-case characters with the I command. To insert both upper-case and lower-case information, use the <i>istring</i> command described below.
i<CR>	Enter insert mode. You must enter a CTRL -Z (^Z) to end insert mode. When you use an i command, you can enter both upper-case and lower-case characters. The character pointer is moved to

Table 5.9 (Continued)

COMMAND	FUNCTION
	the end of the inserted text when you enter the CTRL -Z.
istring [^Z]	Insert the character string <i>string</i> at the position in the buffer pointed to by the character pointer. The CTRL -Z marks the end of the string to be inserted. The character pointer is moved to the end of the inserted string. You can enter both upper- and lower-case characters with the i command.
nJstring^Zstring2^Zstring3 [^Z]	Juxtapose strings. Find <i>string1</i> . Add <i>string2</i> to the end of <i>string1</i> and delete all characters from the end of <i>string2</i> up to but not including the first character of <i>string3</i> . You use the optional final CTRL -Z (^Z) when you want to enter another ED command on the same line.
[+/-]nK	Delete the following (+) or previous (-) <i>n</i> lines.
[+/-]nL	Move the character pointer up (-) or down (+) <i>n</i> lines. If <i>n</i> is zero (0), move the character pointer to the beginning of the current line.
nMcommands [^Z]	Execute the ED commands <i>n</i> times. If <i>n</i> is zero (0) or one (1), repeat the ED commands until an error occurs. You use the terminating CTRL -Z (^Z) to enter an-

Table 5.9 (Continued)

COMMAND	FUNCTION
	other ED command on the same line. Any ED commands after the ^Z are executed only once and are not treated as part of the M command.
<i>nNstring</i> [^Z]	Find the <i>n</i> th occurrence of the character string <i>string</i> . You use the optional terminating CTRL -Z (^Z) when you want to enter another ED command on the same line. The N command performs an automatic translation from lower case to upper case. If you want to find a string containing lower-case letters, use the <i>n</i> form of this command.
O	End the ED session and keep the original file. Do not apply any of the changes made during the session.
[+/-] <i>n</i> P	Display <i>n</i> pages. Each page is 24 lines. Display the <i>n</i> pages before (-) or after (+) the current position of the character pointer. If you supply a zero (0) for <i>n</i> , the current line and the next 23 lines are listed.
Q	Abandon the editing session. Do not save the new (edited) file. Return to CP/M.
R[<i>filename</i>]	Read the file and insert the text into the buffer. Move the character pointer to the end of the inserted

Table 5.9 (Continued)

COMMAND	FUNCTION
	text. If you supply a <i>filename</i> , ED reads the file <i>filename</i> .LIB. If you don't supply a value for <i>filename</i> , ED reads the file X\$\$\$\$\$\$\$.LIB.
<i>n</i> S <i>string1</i> ^Z <i>string2</i> [^Z]	Find <i>string1</i> and replace it with <i>string2</i> . Repeat this substitution <i>n</i> times. If you do not supply a value for <i>n</i> , the substitution is performed once. You use the terminating CTRL -Z (^Z) when you want to enter another ED command on the same line. The S command performs an automatic translation from lower case to upper case. If you want to use lower-case letters in your strings, use the s form of this command.
[+/-] <i>n</i> T	Display the previous (-) or following (+) <i>n</i> lines. If <i>n</i> is zero (0), or if <i>n</i> is not supplied, display the current line. B#T displays the entire buffer.
[+/-]U	Translate all characters in the buffer to upper case. Plus (+) turns on the translation. Minus (-) turns off the translation.
[+/-/0]V	Turn on (+) or off (-) the line number display. The 0 displays the amount of free buffer space in bytes and the total buffer size.
[<i>n</i>]W	Write the following <i>n</i> lines to the temporary output file

Table 5.9 (Continued)

COMMAND	FUNCTION
	<i>filename</i> .\$\$\$\$. If you do not specify a value for <i>n</i> , only the current line is written to the file.
[<i>n</i>]X	Write the following <i>n</i> lines to the temporary file X\$\$\$\$\$\$\$.LIB. You can retrieve these lines with an R command (this is an easy way to move a block of lines). If <i>n</i> is zero (0), ED will DELETE the X\$\$\$\$\$\$\$.LIB file.
<i>n</i> Z	Wait <i>n</i> seconds before resuming ED processing.

***NOTES:** You can use the operand *n1::n2* for any *n* or *n* operand in the ED commands shown in this table. If you use the *n1::n2* form, the ED processor will operate on the lines *n1* through *n2*. If you use this form and omit either *n1* or *n2*, ED assumes the current line for the missing operand.

You can use a # for *n* in the ED commands. # means to use the largest possible value (65535) for *n*

Many of the ED commands show a +/- form. You do not need to specify the plus (+) sign. You do need to specify the minus (-) sign if you want to move backward in the file

The F, I, N, and S commands perform an automatic translation to upper case. If you want to enter both upper and lower case data, use the commands f, i, n, and s.

Example:

ED PGMTST.ASM Edit the file PGMTST.ASM. If the file exists, you must remember to read in the data with an A command before attempting to edit it.

5.5.8 ERA

Format: **ERA** [*disk-id*]:*filename.type*

where:

disk-id is an optional disk identifier.

filename is a valid CP/M filename.

type is a valid CP/M file type.

Description:

You use an **ERA** command to erase one or more files from your disk. If you don't specify a *disk-id* parameter, the file is erased from the currently logged disk.

ERA accepts the wildcard (*) notation for the *filename* and *type* parameters. This allows you to erase a group of files with a single command. Be careful that you don't erase files that you want to keep when you use the wildcard notation.

Examples:

ERA TEST.DTA	Erase the file TEST.DTA from the currently logged disk.
ERA B:MY.PGM	Erase the file MY.PGM from disk B.
ERA *.BAK	Erase all files with a type BAK from the currently logged disk.
ERA A:*. *	CAUTION. Erase <i>all</i> files from disk A. (CP/M asks you whether you really want to erase all files from the disk.)
ERA TEST.*	Erase all files with the filename TEST from the currently logged disk. This would erase, for example, TEST.DTA, TEST.PGM, TEST.ASM, TEST.BAK, TEST.xxx.

5.5.9 LOAD

Format: **LOAD** [*disk-id*:]*filename*

where:

disk-id is an optional disk identifier.

filename is the name of the file containing output from the assembler.

Description:

You use a **LOAD** command to process the output from the assembler (see the description of the **ASM** command) and produce an executable program file. The input file must be named *filename*.HEX. The output file is named *filename*.COM.

You run the output from the **LOAD** processor by entering the filename and hitting a carriage return (see the description on loading and executing a CP/M program in Section 5.5.1).

Example:

LOAD ASMPGM2	Process the file ASMPGM2.HEX (which was created by the assembler) and produce an executable program in the file ASMPGM2.COM.
---------------------	--

5.5.10 MOVCPM

Format: **MOVCPM** [{ * | *size* }] [*]

where:

the first * tells CP/M to calculate the amount of memory available for its use.

size is a two-digit number from 20 through 48 which is the maximum amount of memory available for CP/M in your Commodore 64. You use 44 for a 44K version of CP/M.

the second * tells CP/M to leave the new version in memory for later SYSGEN or SAVE command processing.

Description:

You use a **MOVCPM** command to configure (prepare) a new copy of your CP/M system. Changing CP/M to expect a different memory size is called "moving" the system. The MOVCPM command operates in either of these ways, depending on which parameters you use:

1. "Move" CP/M and immediately execute the new, different sized system. Do not save it on disk.
2. "Move" CP/M and prepare the new system to be saved to disk by a later SYSGEN or SAVE command. *The new CP/M system is NOT written to the disk. You must use a SYSGEN or SAVE command to actually write out the new version of the system.*

If you do not specify any parameters and use a MOVCPM command like this:

```
MOVCPM <CR>
```

CP/M will determine how much memory is available, create a new system, and immediately use the new system.

If you specify the first parameter, you can tell CP/M how much memory it can use by:

- Using the * which tells CP/M to use all available memory.
- Using the *size* parameter which tells CP/M to use *sizeK* bytes of memory.

You can use any decimal integer between 20 and 48 for the *size* value.

If you want to save the new version of CP/M on a disk, you must use the second * parameter and you must supply a first parameter (either *size* or *). You can use this type of command:

```
MOVCPM * * <CR>
```

CAUTION: MOVCPM WILL ONLY CREATE A NEW VERSION OF CP/M. THE NEW VERSION IS NOT SAVED TO A DISK UNTIL YOU USE A SAVE OR SYSGEN COMMAND!

Examples:

- | | |
|-------------|---|
| MOVCPM | Create a new version of CP/M, use all available memory, and immediately execute the new version. Do not save this version. |
| MOVCPM 40 * | Create a new version of CP/M using 40K of memory. Do not execute the version but prepare it to be saved to disk through a SAVE or SYSGEN command. |
| MOVCPM 28 | Create a 28K version of CP/M and execute it. Do not save this version. |

5.5.11 PIP

Format: **PIP**

or

PIP *destination=source[parameter]*

where:

destination tells where you want to copy the file to.
destination is in the form:

[*disk-id:*]*filename.type*

source tells which file to copy. *source* has the same format as *destination*.

parameter is one or more valid PIP parameters separated by zero or more blanks and enclosed in square brackets [].

Description:

You use **PIP**, CP/M's *Peripheral Interchange Program*, to copy files. It doesn't matter what's in the file. PIP

simply copies from the destination file to the source file. The source and destination files can be on the same disk or can be on different disks.

You can specify only the *disk-id* for the *destination* when the file is to be copied to a file with the same *filename.type* on another disk. You can use the wildcard (*) notation for any part of the *source filename* and/or *type*.

You use the *parameters*, or PIP commands, shown in Table 5.10 to have PIP perform some operations on the file during the copy process.

You can use PIP in two different ways:

1. Invoking PIP as a program by entering:

PIP <CR>

In this use, PIP is loaded and returns an * on the next line. You can then enter PIP commands, one per line, until you have finished copying all the files you want to copy. You end the PIP session by hitting a carriage return when PIP prints its * prompt message.

2. Invoking PIP with a command string, by entering:

PIP A:NEW.DTA=B:OLD.DTA <CR>

In this use, PIP is loaded and copies the file B:OLD.DTA to the new file A:NEW.DTA. After the copying is complete, PIP reboots CP/M and returns control to CP/M.

PIP can also copy from device to device. For this type of operation, you can use any of the devices shown in Table 5.11. PIP also uses some "devices" to perform special operations. These are shown in Table 5.12.

You can use PIP to copy the contents of several files to one file (*concatenate* several files). You do this by specifying the source filenames, separated by commas. For example, to copy files FILE1.DTA, FILE2.DTA, and FILE3.DTA to the single file ALLDATA.BAK, you use the command:

PIP ALLDATA.BAK=FILE1.DTA,FILE2.DTA,FILE3.DTA

In the above example, the entire contents of FILE1.DTA are copied to ALLDATA.BAK. Next, PIP copies the entire con-

tents of FILE2.DTA to ALLDATA.BAK, beginning the copy at the end of the current contents of ALLDATA.BAK (the end of the copied FILE1.DTA). FILE3.DTA is then copied at the end of the FILE2.DTA data in ALLDATA.BAK.

NOTE: Be careful when concatenating ASCII files. ASCII files end with a ^ Z (**CTRL** -Z) that PIP copies, along with the data, into your output file. This produces a file with multiple end-of-file markers embedded in it. Many programs will stop reading the file at the first ^ Z.

Table 5.10 PIP Command Parameters

COMMAND	FUNCTION
Dn	Delete all characters after the <i>n</i> th column. Use this when you want to send data to your printer and the data are longer than your printer's carriage. You get only the first <i>n</i> characters.
E	Echo the characters to the console during the copy operation.
F	Remove form feed characters during the copy operation. For feed characters are ASCII value 0CH or CTRL -L (^L).
Gn	Get the file from a different user area. The <i>n</i> can be any decimal integer between 0 and 15.
H	Check the files for correct Intel Hexadecimal format records.
I	Ignore any null records when transferring Intel Hexadecimal records. Null records are those that contain only 00H.

Table 5.10 (Continued)

COMMAND	FUNCTION
L	Convert all upper-case letters to lower-case letters during the copy operation. Only the letters A-Z are converted to a-z. All other characters are unchanged.
N	Append a line number to the beginning of each copied line. A line is a record that ends in an ASCII CR/LF (carriage return/ line feed), which you usually insert when you press the RETURN key. The line numbers begin at one (1) and are incremented by one (1).
O	Copy object files and non-ASCII files. Treat the CTRL -Z (^Z; end-of-file marker as any other character.
Pn	Add a page feed (form feed) every <i>n</i> lines copied. The ASCII form feed character is CTRL -L (^L) or OCH. You use this when you are copying from a file to your printer.
Qs ^ Z	Copy only a section of the file. Stop the copy operation when PIP finds the string <i>s</i> . The CTRL -Z (^Z) marks the <i>end</i> of the string to be found. The characters in string <i>s</i> are converted to upper case <i>only</i> when you specify the destination and source parameters when you invoke PIP. The conversion to upper case is <i>not</i> done when you load PIP into memory and enter several commands to PIP's prompt of *.

Table 5.10 (Continued)

COMMAND	FUNCTION
R	Copy system files. System files have the SYS attribute.
Ss^Z	Copy only a section of the file beginning with the first occurrence of the string s. The CTRL -Z (^Z) marks the end of the string s. See the description of lower- to upper-case conversion for the s string in the Q command description.
Tn	Set tab stops at every n column. This is useful when you are sending output to your printer from a file. The ASCII tab character is 09H or CTRL -I (^I)
V	Verify the copy operation by comparing the source and destination files after the copy is complete.
W	Override the read only attribute and copy into a read only (R/O) file.
Z	Zero the parity bit (8th bit) on ASCII characters.

Examples:

PIP A:FIRST.DTA=B:TEST.DTA

Copy the file from disk B called TEST.DTA to the file on disk A called FIRST.DTA.

PIP B:=A:*. *

Copy all files from disk A to disk B.

PIP CHAPT1.BAK=CHAPT.ONE

Copy the file CHAPT.ONE to the file CHAPT1.BAK. Both files are on the same disk.

PIP CON:=TEST.DTA

Print the file TEST.DTA on the console.

PIP B:BACKUP.PGM=A:PROG234.COM[R]

Copy the system file PROG234.COM on disk A to BACKUP.PGM on disk B.

PIP X.Y=A.B,C.D Copy the two files A.B and C.D to the file X.Y.

PIP

***B:=A:SYSFILE.XXX[R]**

***A:=B:WORDPROG.COM**

***B:=A:*.BAK**

***<CR>**

Copy several files. First, copy the system file SYSFILE.XXX from disk A to disk B. Then copy the program WORDPROG.COM to disk A. Finally, copy all files that have the type BAK from disk A to disk B.

Table 5.11 PIP Logical Devices

NAME	DEVICE
CON:	Console display as PIP output. Keyboard as PIP input.
LST:	The CP/M list device (printer) for PIP output.
PRN:	A special form of the CP/M LST device. PRN handles tabs, determines page breaks, and number lines.

Table 5.12 Special PIP Devices

NAME	DEVICE
NUL:	Send 40 null characters (ASCII value is zero) to the file or device.
EOF:	Send an end-of-file mark (ASCII value is 1AH) or ^Z (CTRL -Z) to the ASCII (not binary) file or device.

5.5.12 REN

Format: **REN**

Format: **REN**[*disk-id:*]*new-file*=*old-file*

where:

disk-id is an optional disk identifier.

new-file is the *new* filename. This must be a valid CP/M filename of the form *filename*[*.type*].

old-file is the current filename. This must be a valid CP/M filename of the form *filename*[*.type*].

Description:

You use a **REN** command to change the name of an existing file. The current filename *old-file* is changed to the new filename *new-file*. You *cannot* use the wildcard form of a CP/M filename when you use the **REN** command. You must specify a valid CP/M filename, but you can specify a blank *type*.

If you are renaming a file that is on the currently logged disk, you don't need to specify the *disk-id* parameter. You *cannot* specify two *disk-id* parameters. **REN** changes the name of the file on the same disk on which the file resides; it does *not* copy the file to another disk. If you want to change the filename and also move the file to another disk, use the **PIP** command.

Examples:

REN A:PRODPGM.COM=TESTPGM.COM

Change the name of the file

TESTPGM.COM on disk A to
PRODPGM.COM.

REN DATA.ARC=DATA.182

Change the name of the file DATA.182 on the currently logged disk to DATA.ARC.

REN B:DATAFILE=TEST.DTA

Change the name of the file TEST.DTA on disk B to DATAFILE.

5.5.13 SAVE

Format: **SAVE** *page-num* [*disk-id:*]*filename*[*.type*]

where:

page-num is the number of 256-byte pages from the TPA to save to the specified file.

disk-id is an optional disk identifier.

filename.type is the name of the file to which CP/M will write the *page-num**256 bytes.

Description:

You use a **SAVE** command to save *page-num* pages (where 1 page = 256K bytes) to the specified file. CP/M copies the information from the TPA which begins at location 100H. You also use the **SAVE** command when you use the **MOVCPM** command to create a new version of CP/M.

You must calculate the number of pages to be saved by dividing the amount of data by 256. You can use DDT to determine the size of your program. When you load a program into the TPA using DDT, DDT will tell you the size of the loaded data. Then, calculate the number of 256-byte pages that this represents.

For example, if you want to save the information from location 100H through 4FFH into the file NEWPGM.COM, you would use the command:

You use the *disk-id* parameter when you want to save the information to a disk that is not the currently logged disk.

Examples:

SAVE 1 A.B Save the contents of memory locations 100H through 1FFH to the file A.B.

SAVE 10 B:PGM.TST Save the contents of memory locations 100H through AFFH to the file PGM.TST on disk B.

SAVE 5X Save the contents of memory locations 100H through 5FFH to the file X on the currently logged disk.

5.5.14 STAT

Format: **STAT**
or
STAT *command*

where:

command is a valid STAT command as described below.

Description:

You use a **STAT** command to display or change status information for a CP/M disk, file, group of files, device, or user number.

To *display* status information, you use one of these forms of the STAT command:

- **STAT** [*disk-id*:]

This shows the number of bytes remaining on disk *disk-id*. If you omit *disk-id*, STAT provides the in-

formation on the currently logged disk. The STAT message is (see Table 5.13 for the valid options):

disk-id: Option, Space: nnK

- **STAT [*disk-id*:]DSK:**

This shows the drive characteristics for disk *disk-id*. If you omit *disk-id*, STAT provides information related to the currently logged disk. The STAT information is:

<i>disk-id:</i>	Drive Characteristics
1088:	128 Byte Record Capacity
136:	Kilobyte Drive Capacity
64:	32 Byte Directory Entries
64:	Checked Directory Entries
128:	Records / Extent
8:	Records / Block
34:	Sectors / Track
2:	Reserved Tracks

- **STAT [*disk-id*:]*filename*[*.type*]**

This shows the characteristics of the file(s) specified. You can use the wildcard (*) notation for the *filename* and/or *type* parameters. If you don't specify a *disk-id* parameter, STAT uses the currently logged disk.

The STAT information for the specified file(s) is shown as:

Recs Bytes Ext Acc

nnn nK e Options disk-id:filename.type

...for each file specified...

Bytes Remaining on *disk-id*: *nnK*

where:

nnn is the number of 128-byte records for the file.

nK shows the file size in 1024-byte blocks.

e shows the number of extents used for the file.

Options shows a valid STAT option from Table 5.13.

disk-id:filename.type shows the filename.

If you specify a file which is not on the disk, STAT returns an error message:

FILE NOT FOUND

- **STAT {DEV: | VAL: | USR:}**

This shows the information for the CP/M devices (DEV:), STAT commands and external peripheral options (VAL:), or user numbers (USR:). This function refers to the I/O byte, which is not implemented and always returns the default device assignments.

Table 5.13 STAT Command Options

OPTION	MEANING
DSK:	Show the characteristics of the specified drive.
DEV:	Show the characteristics of the CP/M system devices.
USR:	Show the files related to each USER number on the specified disk.
VAL:	Show the possible STAT commands and devices.

NOTE: The DEV· and VAL· options refer to the I/O byte, which is not implemented in the Commodore 64 BIOS.

To *change* status information, you use one of these forms of the STAT command (valid STAT attributes are shown in Table 5.14):

- **STAT *disk-id*: =R/O**

This changes the disk *disk-id* to a temporary read only mode (R/O).

- **STAT** [*disk-id:*]*filename*[*.type*]=**x*
where *x* is {**R/O** | **R/W** | **SYS** | **DIR**}

This changes the specified file(s) to read only (**R/O**), read/write (**R/W**), system (**SYS**), or nonsystem (**DIR**). You can use the wildcard (*) notation for the *filename* and/or *type* parameters. To change all your program files on disk A to read only, you enter the command:

STAT A:*.COM \$R/O

Table 5.4 STAT Command Attributes

ATTRIBUTE	MEANING
DIR	Set the non-SYSTEM attribute for the file(s).
R/O	Set the file or disk to read only.
R/W	Set the file to read/write.
S	Show the size(s) of the file(s) based on the file last record number(s).
SYS	Set the SYSTEM attribute for the file(s).

Examples:

- | | |
|---------------------------|--|
| STAT *.* | Show the statistical information for all files on the currently logged disk. |
| STAT A.B | Show the statistical information for the file A.B on the currently logged disk. |
| STAT DSK: | Show the statistical information for the currently logged disk. |
| STAT *.COM \$R/O | Set all files on the currently logged disk which have a <i>type</i> COM (CP/M program files) to read only. |
| STAT NEW.DTA \$R/W | Set the file NEW.DTA to read/write. |

5.5.15 SUBMIT

Format: **SUBMIT** [*disk-id:*]*filename* [*parameters*]

where:

disk-id is an optional disk identifier.

filename is the name of the file containing the CP/M commands. This file must be named *filename.SUB*.

parameters are optional parameters passed to the SUBMIT commands.

Description:

You use a **SUBMIT** command to send a group of commands to CP/M for execution. SUBMIT makes your Commodore 64 operate in *batch* mode where, with a single command, you can execute any number of programs or utilities.

The file containing the commands must have a *type* SUB. This file can contain any CP/M *commands*. CP/M creates a file called *\$\$\$SUB* as a temporary work file when you execute a SUBMIT command.

NOTE: All commands in a SUBMIT file must be in upper case.

For example, you could have these commands in file DISK DTA.SUB:

```
DIR
STAT *.*
ERA *.BAK
STAT DSK:
```

To execute all four of these CP/M commands, you simply enter:

```
SUBMIT DISKDTA <CR>
```

Remember, CP/M then executes the commands in the file *in the order in which the commands appear in the file*. SUBMIT processing only executes commands. It does not pass any information to the programs it executes. If you want to pass data to the programs, use the XSUB command.

You can *chain* from one .SUB file to another. Whenever a SUB file finds another SUBMIT command, the first file is stored and the second file becomes active. When the second file's commands are finished, the first .SUB file becomes active at the command following the SUBMIT command. For example, you could have these two files:

File A.SUB contains:

```
STAT DSK:
SUBMIT B
STAT DSK:
```

File B.SUB contains:

```
ERA *.BAK
DIR
```

When you enter the command:

```
SUBMIT A
```

the following commands are executed:

```
STAT DSK:
ERA *.BAK
DIR
STAT DSK:
```

You can also pass parameters to the .SUB file. The parameters are sequentially numbered in the file and have the form:

```
$n
```

where:

n starts at 1 and is incremented by 1.

The parameters can be any information required by the commands in your .SUB file. They can be filenames, disk id's, file types, or anything that you need. SUBMIT does a straight substitution of the parameter values for the parameter indicators (\$*n*) in the .SUB file before passing the commands to CP/M. The first parameter goes to all occurrences of \$1; the second to \$2, etc.

Suppose you want to check the status of your disk and then edit a file. You could have a file called DSKEDIT.SUB that contains this information:

```
STA $1:DSK:
```

```
ED $2.$3
```

```
STAT $1:$2.$3
```

Then, to check the status of Disk A and edit the file MY.DTA, you would use this submit command:

```
SUBMIT DSKEDIT A MY DTA
```

SUBMIT processing replaces the parameter indicators with the values in your SUBMIT command and the data in file. When passed to CP/M for processing, DSKEDIT.SUB looks like this:

```
STAT A:DSK:
```

```
ED MY.DTA
```

```
STAT A:MY.DTA
```

When you are using SUBMIT parameters, you can enter these special characters through the parameter string:

- To enter a \$ as data, you must enter two consecutive \$\$. This is transferred to the command line as a \$. Thus, to enter the value "\$XY" as a parameter, you must use \$\$XY.
- To enter a control character, use the up-arrow symbol (^) followed by the control character. To enter **CTRL** X, you would enter the character string ^X.

You can have a SUBMIT command as the *last* command in a .SUB file. This lets you *chain* from one .SUB command file to another.

Examples:

- SUBMIT STARTUP This executes the CP/M commands in the file called STARTUP.SUB.
- SUBMIT NEW A B This executes the CP/M commands in the file called NEW.SUB. The value "A" is passed to any %1 indicators in the file. The value "B" is passed to any %2 indicators.

5.5.16 SYSGEN

Format: **SYSGEN** [[*disk-td*:]*filename.type*]

where:

disk-td is an optional disk identifier.

filename.type is the name of the file that will contain the new copy of the system.

Description:

You use a **SYSGEN** command to create a new copy of your CP/M operating system. The CP/M system is stored on special tracks called the *system tracks* (tracks 0 and 1). These tracks never appear in the file directory listing and you cannot read or write to these tracks as part of processing any normal program.

You need the system tracks on any disk from which you may do a warm or cold start. It's a good idea to have a copy of the system on most disks that contain programs. Whenever you enter a **CTRL**·C (^C), CP/M reloads part of its system tracks (the BDOS and CCP) in a *warm start*.

You use the SYSGEN command to copy these tracks from one disk to another or to create a new copy of the system after you have used a MOVCPM command.

You use a SYSGEN command in one of these three ways:

1. To copy your CP/M system from one disk to another. You do not make any changes to the system; you simply copy it.
2. You use MOVCPM to create a different sized version of CP/M and you use SYSGEN to copy it to a disk.
3. You use DDT to make special changes to your copy of CP/M and you use SYSGEN to write the system to a disk.

SYSGEN does not destroy any information currently on the user area of a disk. SYSGEN simply writes a new copy of the CP/M system on the disk.

If you specify a *disk-id* parameter, SYSGEN does not ask for the source drive but uses the value you selected for *disk-id*.

If you want to create a new copy of CP/M after using MOVCPM to create a new version, you follow this procedure. The text that you enter is shown in boldface. The messages from CP/M are shown in *italics*.

SYSGEN <CR>

COMMODORE 64 SYSGEN VERSION 2.0

SOURCE DRIVE NAME

(OR RETURN TO SKIP) <CR>

DESTINATION DRIVE NAME

(OR RETURN TO SKIP) B<CR>

DESTINATION ON B, THEN TYPE RETURN <CR>

FUNCTION COMPLETE

To copy a version of CP/M from one disk to another, follow the above procedure but supply the appropriate answers for the source and destination drives.

NOTE: If you SYSGEN onto your current system disk a version of CP/M that is a different size from the one you're running, you CANNOT warm start the system. The location of operating system components will not match and the CP/M will crash.

Example:

To copy the system tracks from your current disk to another disk, enter:

SYSGEN <CR>

and answer the questions that CP/M asks.

5.5.17 TYPE

Format: **TYPE** [*disk-id*]:*filename.type*

where:

disk-id is an optional disk identifier.

filename.type is the name of the file to be listed on your screen.

Description:

You use a **TYPE** command to list an ASCII format file on your screen. If you don't specify a *disk-id* value, CP/M uses the currently logged disk. You must specify a valid CP/M filename. **TYPE** does *not* accept the wildcard (*) notation.

You can use a **CTRL** -P (^P) before you enter your **TYPE** command and the listing will appear on your screen and on your printer. All commands and data continue to appear on both the screen and the printer until you enter another ^P.

You can stop the **TYPE** listing by pressing any key. You can *temporarily stop* the listing by pressing a **CTRL** -s (^S); you restart the listing by pressing any key.

Remember that **TYPE** displays the contents of the specified file, assuming that the file contains ASCII characters. If you **TYPE** a program file (.COM), you will see garbage on your screen. Be sure that you are listing a text file when you use **TYPE**.

Examples:

TYPE A:BILLS.LST List the contents of the file on disk A called BILLS.LST.

5.5.18 USER

Format: **USER** [*user-num*]

where:

user-num is a decimal integer between 0 and 15.

Description:

You use a **USER** command to display and change the current user number. CP/M assumes a default user number of zero (0).

Once you change the user number, you can access only those files associated with the new user number. You can always enter a user number 0 to return to the default setup.

To *display* the current user number enter:

USER <CR>

To *change* the current user number to 5 enter:

USER 5

You should not change the user number unless you want to protect certain files from use by those who do not know the associated user number. In a single-user CP/M system, it's generally unnecessary to change the user number.

Examples:

USER 2 Change the user number to 2.

USER Display the current user number.

5.5.19 XSUB

Format: XSUB

Description:

You use an XSUB command when you want to enter more than commands in a .SUB file. XSUB is a subset of SUBMIT processing and *CANNOT* be entered as a response to the CP/M prompt. XSUB may appear *only* in a SUBMIT (.SUB) file. Read the description of the SUBMIT command for full details on how .SUB files are processed.

XSUB must be the *first* command in your .SUB file. You can enter parameters on an XSUB command in the same way as for a SUBMIT command.

XSUB allows you to enter data that would normally be entered through the keyboard for some programs. If you are using a program that accepts buffered console input (uses BDOS function 10), then the program will accept the answers from the XSUB file instead of waiting for you to enter data from the keyboard. Not all programs do this, but all the CP/M utilities and commands do accept data in this manner.

Example:

You want to submit a file that will run DDT and load the file you specify. Your file called DDTRUN.SUB contains:

```
XSUB
DDT
I$1.$2
R
```

You can submit this file and specify that the file WORDPROC.DTA be read into memory through DDT by entering:

```
SUBMIT DDTRUN WORDPROC DTA
```

This SUBMIT command accepts the DDT commands to read the file WORDPROC.DTA into memory by processing the information after the XSUB command.

CHAPTER

6

CP/M ON THE COMMODORE 64

- The Structure of CP/M
 - The BOOT Programs
 - The BIOS Programs
 - CP/M Disk Organization
 - The CP/M BDOS
 - Calling a Z80 Program from the 6510
 - Calling a 6510 Program from the Z80
 - Program Execution under CP/M
-
- Z80 Schematic
 - Commodore 64 Schematic

In this chapter, you will find technical information about implementing CP/M on your Commodore 64. You will need this information only if you intend to make changes or additions to CP/M as supplied with your Commodore 64 and its Z80 cartridge.

CP/M was one of the first microcomputer operating systems designed to run on machines of more than one manufacturer. It is written in Intel 8080 Assembler language. The Z80 add-on processor on your Commodore 64 executes a superset of the 8080 machine language. Any program written for the 8080 processor will run on the Z80, but the reverse may not be true.

When CP/M is running on your Commodore 64, *the 6510 main processor and the Z80 add-on processor* are alternately active. The two processors trade control of the computer according to what operations are required. Because device drivers already reside in your Commodore 64 operating system, all input and output is performed by the 6510. The Z80 runs only the CP/M operating system, its utilities, and applications.

In addition to the standard functions required by the CP/M operating system, you can access your own *special purpose routines* running in 6510 native mode. This is useful, for example, if you want to attach an instrument to the optional IEEE interface cartridge on your Commodore 64. You could then easily code a driver for the instrument and gain access to it through a well defined, and protected, interface.

6.1 THE STRUCTURE OF CP/M

The principal component of CP/M is the **Basic Disk Operating System (BDOS)**. All requests for operating system services — disk input/output, printer output, screen output — are carried out through a set of standard calls to the BDOS.

NOTE: It is possible to call entry points in the CP/M BIOS directly. This technique is **NOT** recommended unless you are very sure of what you are doing. **WARNING.** Direct BIOS calls may be incompatible with future CP/M releases.

A second major component of CP/M is the **Console Command Processor (CCP)**. The CCP analyzes and interprets the commands that you enter from the keyboard, initiating whatever action you request. Of the resident CP/M system, the CCP occupies the lowest memory areas (see Figure 6.3).

Transient programs (those not a permanent part of the BDOS) are loaded into the **Transient Program Area (TPA)** and may, if they need the space, overlay the CCP when executing.

If a program executing in the TPA does overlay the CCP, the CCP must be reloaded when the transient program terminates. You will see this CCP reload operation (a "warm boot") as a line of asterisks appearing on your screen after a program has finished.

The final major component of CP/M is the **Basic Input/Output System (BIOS)**. This has nothing to do with the BASIC language. The BIOS is the component of CP/M that allows CP/M to be run on a variety of machines. The BIOS forms a bridge between the BDOS and the individual characteristics of the machine that it runs on. Each machine has a specially tailored BIOS that supports the hardware and peripherals attached to it.

The CP/M BIOS is much like the CBM Kernal in your Commodore 64. Like the Kernal, the BIOS contains a set of standard routines that give you access to hardware functions.

Your Commodore 64 has a unique BIOS that provides easy access to the standard Commodore 64 peripherals, either serial or IEEE.

6.1.1 How CP/M Works on Your Commodore 64

Four specially tailored assembly language programs and the CP/M operating system are required to run CP/M on your Commodore 64. Two of the assembly language programs run under the 6510 microprocessor and two under the Z80 microprocessor:

- 6510 CP/M BOOT program (BOOT65)
- Z80 CP/M BOOT program (BOOT80)

- 6510 BIOS (BIOS65)
- Z80 BIOS (BIOS80)

The BOOT programs “bootstrap” CP/M. That is, they load it into memory, initialize some areas, and begin its execution. Once the BOOT programs have completed their tasks, they are no longer needed and the memory they occupied is used for other purposes.

CP/M comes from Digital Research as a core operating system. It needs an add-on software component called a **BIOS (Basic Input/Output System)**. The BIOS contains a set of entry points that perform specific “primitive” tasks for CP/M, such as:

- Set the track number for the next read or write operation.
- Write a character to the printer.
- Read a character from the keyboard.

CP/M is not concerned with how these tasks are performed. All this work is taken care of in the custom BIOS written specifically to support a certain hardware environment. It is this BIOS that allows CP/M to run many different machines equipped with many different peripherals.

On your Commodore 64, the CP/M BIOS is in two parts. One part runs under the Z80 add-on processor (BIOS80) and the other under the 6510 Commodore 64 main processor (BIOS65). This arrangement allows the 6510 to serve as an *input/output processor* for the Z80, handling all disk, printer, keyboard, and screen input or output.

The 6510 part of the BIOS initiates execution of CP/M under the Z80 processor by transferring control to the Z80 BOOT program, which loads CP/M and BIOS80. Whenever a processor is switched on, it resumes execution at the instruction immediately following the instruction that switched it off. This means that when the Z80 returns control to the 6510, execution will resume within BIOS65.

When a CP/M program, running on the Z80, requests an input/output operation, the Z80 BIOS places a *function code and any required parameter values* at predetermined locations in memory. Remember, memory is shared between the two processors, which makes it very easy for them to pass data back and forth.

Once these parameter values are in place, BIOS80 switches the Z80 out and the 6510 in. The 6510 resumes execution in the 6510 portion of the BIOS. BIOS65 examines the function code passed to it by BIOS80 and initiates the indicated action.

Once the 6510 has completed the action, BIOS65 places return values and/or flag values into predetermined locations and switches control back to the Z80 processor.

Under the Z80 processor, execution resumes where it left off in BIOS80. BIOS80 examines the shared memory areas to determine the success or failure of the requested function and carries out any other action necessary to complete the function.

6.1.2 6510 Memory Use

Figure 6.1 shows the memory allocation as seen from the 6510 running in native mode. Figure 6.2 shows details on the BIOS65 memory area.

6510 CP/M Memory Map

6510

ADDRESS

\$FFFF

\$F000

6510 KERNAL ROM

\$E000

6510 I/O SYSTEM

\$D000

**48K RAM AVAILABLE FOR Z80
RUNNING CP/M**

\$1000

BIOS65 AND SHARED DATA AREAS

\$0800

0400 TO 07FF SCREEN RAM

0000 TO 03FF ZERO PAGE AND 6510 STACK

\$0000

The addresses shown are for the 6510 microprocessor. For Z80 addresses, subtract \$1000 hexadecimal from the addresses shown (see Section 6.1.3 for an explanation of Z80/6510 address conversion).

NOTE: If you add the IEEE interface cartridge to your Commodore 64 system, you can run only a 44K version of CP/M. The top 4K (\$C000—\$D000) of the CP/M 48K area is used to handle the IEEE interface cartridge.

BIOS65 Memory Map

6510

ADDRESS

\$1000

\$0F00

\$0E00

\$0D00

BIOS65

\$0C00

\$0B00

\$0A00

SHARED DATA

\$0900

DISK I/O BUFFER

\$0800

The addresses shown are for the 6510 microprocessor. For Z80 addresses, add \$F000 hexadecimal to the addresses shown (see Section 6.1.3 for an explanation of Z80/6510 address conversion).

6.1.3 Addresses under CP/M

You can see from the memory map in Figure 6.3 that the Z80 processor uses the memory between \$1000 and \$BFFF—a 48K byte area. CP/M, however, makes use of fixed areas in the zero page (\$0000–\$0100) of memory. This area is also required by the Commodore 64 operating system.

To avoid a conflict in the use of the zero page and to provide space for BIOS65, all Z80 addresses have \$1000 added to them. Thus, the Z80 address \$0000 becomes actual address \$1000. Table 6.1 shows the mapping between Z80 addresses and actual memory addresses.

NOTE: If you are using the optional IEEE interface cartridge, you have only 44K bytes available for CP/M. The IEEE bus access routines require an additional 4K at the high end of the CP/M memory (\$8000–\$BFFF).

Table 6.1 Z80 to 6510 Actual Address Mapping

Z80 ADDRESS	ACTUAL (6510) ADDRESS
0000->0FFF	1000->1FFF
1000->1FFF	2000->2FFF
2000->2FFF	3000->3FFF
3000->3FFF	4000->4FFF
4000->4FFF	5000->5FFF
5000->5FFF	6000->6FFF
6000->6FFF	7000->7FFF
7000->7FFF	8000->8FFF
8000->8FFF	9000->9FFF
9000->9FFF	A000->AFFF
A000->AFFF	B000->BFFF
B000->BFFF	C000->CFFF
C000->CFFF	D000->DFFF
D000->DFFF	E000->EFFF
E000->EFFF	F000->FFFF
F000->FFFF	0000->0FFF

NOTE: Notice that to access the 6510 low addresses, you reference the Z80 high addresses.

6.1.4 Z80 Memory Use

The amount of memory available to CP/M on your Commodore 64 depends on your hardware configuration. If you are using the standard *Commodore 64 serial disk drives and printer*, CP/M can occupy a maximum of 48K bytes. If you have acquired the *IEEE interface cartridge*, CP/M can occupy a maximum of 44K bytes. The IEEE interface cartridge consumes 4K at the high end of the CP/M address space (see Figure 6.1).

You can, of course, generate a CP/M system that is smaller than the maximum available space. You can do that if you need space for a routine that must run in Commodore 64 native mode (under the 6510 processor). You can, for example, generate a 40K CP/M version and have 8K (or 4K if you have the IEEE cartridge) available for your Commodore 64 native mode routine. Figure 6.3 shows a diagram of the Z80 address space.

Z80 Memory Map

ADDRESS		
44K	48K	
\$AFFF	\$BFFF	
		BIOS80
\$AA00	\$BB00	
		BDOS
\$9C06	\$AC06	
		CCP
\$9400	\$A400	
		TPA
		(44K—33,792 bytes)
		(48K—37,888 bytes)
\$0100	\$0100	
		ZERO PAGE
\$0000	\$0000	

Many microcomputer operating systems use the zero page of memory (addresses between \$0000 and \$0100) to hold important values. Both CP/M and your Commodore 64

operating system do this. Table 6.4 shows the contents of the CP/M Zero Page.

Table 6.2 CP/M Zero Page

ADDRESS	CONTENT
\$0000 - \$0003	Contains a jump instruction to the warm start entry point in the BIOS.
\$0004	Contains the current default disk drive number (0=A and 1=B) in the low order 4 bits and the I/O byte in the high order 4 bits.
\$0005 - \$0007	Contains a jump instruction to the BDOS main entry point. The value stored in locations \$0006 - \$0007 is the lowest address <i>required</i> by CP/M. You also use this jump instruction (or the address) when you make direct BDOS calls.
\$0038 - \$003A	This is Restart Location 7 and is used by DDT for programmed breakpoints (an RST 7 instruction causes a call to this location).
\$005C - \$006C	This is the first default file control block for use by transient programs.
\$006C - \$007C	This is the second default file control block for use by transient programs.

Table 6.2 (Continued)

ADDRESS	CONTENT
\$007D – \$007F	This location contains the random record position for random file access via the first default file control block.
\$0080 – \$00FF	This is the default 128-byte disk input/output buffer. This area also receives the command line that you enter when your program is loaded by the CCP.

NOTE: The areas of the zero page not shown in this table are reserved for future use. You should not use any of these areas in programs you write unless you are sure of their use

6.2 THE BOOT PROGRAMS

The BOOT programs — BOOT65 and BOOT80 — are used to load CP/M from disk. Once they have completed this task, the memory they occupy is used for other purposes.

The **BOOT65** program is in the file called "CP/M" that you **LOAD** and **RUN** to start execution of the CP/M operating system on your Commodore 64. You can find a listing of this program in Appendix E. The actual assembly language program source is available on one of your CP/M system diskettes.

You **LOAD** and **RUN** **BOOT65** as you would any BASIC program on your Commodore 64. If you **LIST** it, you will see that it contains a single BASIC statement:

10 SYS (2036)

This statement transfers control to the actual **BOOT65** code located at decimal address 2036.

The program then reads in the **BIOS65** and **BOOT80** pro-

grams and places them at the correct locations in memory. Finally, BOOT65 transfers control to the startup code in BIOS65.

The **BOOT80** program is a Z80 assembly language program that is the first program to execute when the Z80 processor is switched on. You can find a listing of this program in Appendix E. The actual assembly language program source is available on one of your CP/M system diskettes.

BOOT80 is loaded by the BOOT65 program at the Z80 reset address \$0000 (6510 address \$1000). When the Z80 is first turned on, it always begins execution at address \$0000.

BOOT80 loads:

- Z80 BIOS (BIOS80)
- CP/M CCP (CP/M Command Processor)
- CP/M BDOS (Basic Disk Operating System)

When these programs are loaded, BOOT80 transfers control to the cold start entry point in BIOS80, thus beginning actual CP/M operating system execution.

6.3 THE BIOS PROGRAMS

The BIOS (Basic Input/Output System) is the specially tailored link between the CP/M operating system and the individual peripherals—printer, disk drives, screen—attached to your Commodore 64.

Each computer that runs CP/M has its own unique BIOS. On your Commodore 64 the BIOS is in two parts:

- BIOS65 executes under the 6510 main processor.
- BIOS80 executes under the Z80 add-on processor.

These two portions of the BIOS operate together to make your Commodore 64 peripherals available to CP/M.

Why are there two programs for the BIOS? Your Commodore 64 already has code in place to handle its peripherals. Thus more memory is made available for CP/M and your CP/M-based applications by simply providing a link to that existing code, rather than trying to re-implement the peripheral-handling code on the Z80.

In operation, BIOS80 is called from CP/M with a request

for an input/output operation. BIOS80 places required parameter values and a function flag in certain memory locations, then switches control from the Z80 back to the 6510 Commodore 64 main processor.

The 6510 resumes execution where it left off in BIOS65. BIOS65 examines the function code stored in memory to find out what it should do, carries out the task (usually an input/output request), places the result in a predetermined memory location, and switches the Z80 back on.

The Z80 resumes execution where it left off in BIOS80. BIOS80 retrieves the results passed to it from BIOS65 and returns the proper information to CP/M.

BIOS80 is called from the CP/M BDOS to perform the following functions:

- cold start boot
- warm start boot
- console (keyboard) status check
- get keyboard character (console input)
- write character to screen (console output)
- print a character (lister output)
- move disk head to the home position
- select disk
- set track to read/write
- set sector to read/write
- read disk sector
- write disk sector
- check printer status (lister status)
- sector translation

The *punch* and *reader* functions of the BIOS are meaningless on your Commodore 64. These are null routines in BIOS80.

Some of the functions listed above simply cause values to be placed in predefined memory locations. Others result in a transfer to the 6510 portion of the BIOS where the actual work is performed.

Before BIOS80 switches control back to the 6510, it places a *function code* at location \$F900 (\$0900 relative to the 6510). This code, which currently ranges from 0 to 9 and 255, tells BIOS65 what action is required. These function codes and their meanings are shown in Table 6.3.

Table 6.3 BIOS80/BIOS65 Function Codes

NUMBER	FUNCTION
0	Read the specified sector
1	Write the specified sector
2	Get a character from the keyboard
3	Write a character to the screen
4	Check the printer status
5	Write a character to the printer
6	Disk format command
7	Jump to 6510 address \$0E00
8	Jump to 6510 address \$0F00
9	Jump indirect via a 6510 address stored at \$F906
10->254	Reserved for future use
255	Execute a cold start reset on your Commodore 64

Table 6.4 BIOS80/BIOS65 Communication Addresses

ADDRESS	CONTENT
Z80 6510	
\$F900 \$0900	Command register: contains one of the function codes as shown in Table 6.2.
\$F901 \$0901	Data register: used to pass data and error indicators between the two BIOS.
\$F902 \$0902	Sector register: contains the current sector number for disk read and write requests.
\$F903 \$0903	Track register: contains the current track number for disk read and write requests.
\$F904 \$0904	Drive register: contains the disk drive number for disk read and write requests.
\$F905 \$0905	Keyboard register: contains the last character read from the keyboard.

BIOS65 and BIOS80 communicate with each other through a series of contiguous memory locations as shown in Table 6.4.

6.4 CP/M DISK ORGANIZATION

Your Commodore 64 CP/M BIOS programs provide a completely compatible interface between your disks and the CP/M BDOS. All disk-related functions expected by the CP/M BDOS are available through your BIOS programs.

The organization of a CP/M disk is different from the organization of a standard Commodore 64 disk. The CP/M disk has somewhat less capacity than a Commodore 64 format disk.

A Commodore 64 CP/M disk is formatted as **35 tracks containing 17 256-byte sectors (0–16)** where *track 1* is the outermost track and track 35 is the innermost track. A Commodore 64 CP/M disk can hold a maximum of **136,000 characters of user data**.

Notice that the full disk capacity (152,320 characters) is not available for user data storage.

Table 6.5 shows the allocation of tracks on your Commodore 64 CP/M format disk.

Table 6.5 CP/M Disk Track/Sector Allocations

TRACK	SECTOR	CONTENT
1	0	BOOT65 (Commodore 64 file "CPM")
1	1–>4	BIOS65
1	5	BOOT80
1	6–>13	CP/M CCP (Command Processor)
1&	14–>16	CP/M BDOS
2	0–>10	
2	11–>16	BIOS80
3	0–>7	CP/M Disk Directory
3	8–>16	CP/M Disk Space
4–>17	0–>16	CP/M Disk Space
18	0–>16	Commodore 64 Directory
19–35	0–>16	CP/M Disk Space

NOTE: The Commodore 64 Directory written on track 18 allows you to start CP/M from Commodore 64 running in native mode. This directory shows that only a single file—CPM—exists on the disk. The standard Commodore 64 Block Availability Map (BAM) indicates that the disk is completely full.

6.5 THE CP/M BDOS

The CP/M **Basic Disk Operating System** (BDOS) provides a standard interface between CP/M application programs and the hardware on which they run. All input/output and operating system service requests are routed through the BDOS. Because of this, you don't have to write device-specific code into your application program for every system that it might run on. The device-specific code for a particular system is written only once—in the CP/M BIOS.

The standard BDOS interface means that software can be written and run on *any system able to support CP/M*, as long as the software developer stays within the BDOS standard.

The 39 BDOS functions (numbered 0–37 and 40 decimal) perform tasks valuable in almost any application. For example, they

- Read a character from the keyboard.
- Write a character to the keyboard.
- Open a disk file.
- Print a string.
- Write to the printer.
- Delete a file.
- Create a file.

For a list of the BDOS functions, see Table 6.6.

You call the BDOS from Z80 Assembler or other languages through the *BDOS jump vector* at **Z80 address \$0005**. This jump vector contains a single jump instruction:

JMP BDOS-ADDRESS

The *bdos-address* varies with the size of the CP/M system you have generated. The JMP instruction itself is placed at location \$0005 when CP/M is loaded.

To use the BDOS functions, you code:

CALL 5

When the BDOS has completed the function, it returns control to the statement following the CALL statement.

NOTE: Bytes 6 and 7 of the BDOS jump vector contain the lowest address required by CP/M (stored as low byte/high byte). This means that your application program can use memory up to, but not including, this address.

BDOS functions are numbered. Some require that you pass to them the parameter values or the address of a parameter in certain registers. Some return an indicator or error code in a register.

When calling a BDOS function, you always load the **BDOS function code in register C**. If the function requires that you pass it *parameters*, you place:

- Single-byte parameters in register E.
- Double-byte parameters in register pair DE.

If the function *returns a value* to you, you find:

- Single-byte returns in register A.
- Double-byte returns in register pair HL.

NOTE: The BDOS does NOT preserve values stored in the Z80 registers. If you want to protect values stored in registers, you should push them onto the stack before you call the BDOS. You can then pop them off the stack on return from the BDOS call.

6.5.1 Sample BDOS Function Call

As an example of a BDOS function call, we will use Function 1, the Console (keyboard) Input function. Function 1 returns in register A the last character entered from the keyboard. To use Function 1, you can write code like the following:

```
                MVI C,1          ;LOAD FUNCTION 1 INTO REGISTER C
;              CALL 0005H        ;CALL THE BDOS JUMP VECTOR
;              WHEN THE BDOS HAS A CHARACTER, IT RETURNS HERE
;              REGISTER A CONTAINS THE INPUT CHARACTER
;
                STA KEYCHAR      ;STORE REGISTER A IN KEYCHAR
                                VARIABLE
```

Table 6.6 BDOS Functions

FUNCTION (Register C)	DESCRIPTION
0 SYSTEM RESET	
	INPUT: NONE RETURN: NONE
	Returns control to the CCP and resets CP/M as though you rebooted.
1 CONSOLE INPUT	
	INPUT: NONE RETURN: A ← character input
	Reads a character from the keyboard. Examines the character to see if it is a CP/M control character.

Table 6.6 (Continued)

FUNCTION (Register C)	DESCRIPTION
----------------------------------	--------------------

2 CONSOLE OUTPUT

INPUT: E \leftarrow character to display

RETURN: NONE

Writes a character to the screen.

3 READER INPUT

INPUT: NONE

RETURN: A \leftarrow character read

This function is not supported on your Commodore 64.

4 PUNCH OUTPUT

INPUT: E \leftarrow character to punch

RETURN: NONE

This function is not supported on your Commodore 64.

5 LIST OUTPUT

INPUT: E \leftarrow character to print

RETURN: NONE

Writes a character to your printer.

Table 6.6 (Continued)

FUNCTION (Register C)	DESCRIPTION
--------------------------	-------------

6 DIRECT CONSOLE I/O

INPUT: E \leftarrow character to display (output)
E \leftarrow OFFH (input)
RETURN: A \leftarrow character (input)
A \leftarrow status (output)

Performs raw console input (read from keyboard) and output (write to screen). Characters are transferred through the BDOS without being examined or changed.

7 GET I/O BYTE

INPUT: NONE
RETURN: A \leftarrow I/O byte

The I/O byte function is not supported on your Commodore 64.

8 SET I/O BYTE

INPUT: E \leftarrow new I/O byte
RETURN: NONE

The I/O byte function is not supported on your Commodore 64.

9 PRINT STRING

INPUT: DE \leftarrow string address
RETURN: NONE

Writes the character string to the screen. The string must terminate with a "\$".

Table 6.6 (Continued)

FUNCTION (Register C)	DESCRIPTION
--------------------------	-------------

10 READ CONSOLE BUFFER

INPUT: DE \leftarrow buffer address
RETURN: characters in buffer

Reads from the keyboard until a carriage return or CTL-M is entered or until the keyboard buffer overflows.

11 GET CONSOLE STATUS

INPUT: NONE
RETURN: A \leftarrow console status

Checks the keyboard status. A contains 0FFH if a character is ready; 00H if not.

12 RETURN VERSION NUMBER

INPUT: NONE
RETURN: HL \leftarrow version number

Returns the CP/M version number.

13 RESET DISK SYSTEM

INPUT: NONE
RETURN: NONE

Resets the entire disk system to its initial state.

Table 6.6 (Continued)

FUNCTION (Register C)	DESCRIPTION
--------------------------	-------------

14 SELECT DISK

INPUT: E \leftarrow disk number to select

RETURN: NONE

Selects a disk (A=0 and B=1).

15 OPEN FILE

INPUT: DE \leftarrow address of FCB

RETURN: A \leftarrow directory code

Opens a disk file for processing. Returns a 255 in A if the file could not be found.

16 CLOSE FILE

INPUT: DE \leftarrow address of FCB

RETURN: A \leftarrow directory code

Closes a disk file. Returns a 255 in A if the file could not be found.

17 SEARCH FOR FIRST

INPUT: DE \leftarrow address of FCB

RETURN: A \leftarrow directory code

Searches for the first file matching the name given in the FCB. Returns a 255 in A if no match was found.

Table 6.6 (Continued)

FUNCTION (Register C)	DESCRIPTION
--------------------------	-------------

18 SEARCH FOR NEXT

INPUT: NONE

RETURN: A ← directory code

Similar to Function 17, but begins search where 17 left off. Also returns a 255 in A if no match was found.

19 DELETE FILE

INPUT: DE ← address of FCB

RETURN: A ← directory code

Deletes a disk file. Returns a 255 in A if the file could not be found.

20 READ SEQUENTIAL

INPUT: DE ← address of FCB

RETURN: A ← directory code

Reads the next 128-byte record into the memory pointed to by the current DMA address. Returns a 00H in A if the read succeeded; non-zero if end-of-file was encountered.

21 WRITE SEQUENTIAL

INPUT: DE ← address of FCB

RETURN: A ← directory code

Table 6.6 (Continued)

FUNCTION (Register C)	DESCRIPTION
	Writes the 128-byte record pointed to by the current DMA address. Returns a 00H in A if the write succeeded; a non-zero for a full disk.
22 MAKE FILE	
INPUT: DE \leftarrow address of FCB RETURN: A \leftarrow directory code	
Creates the disk file named in the FCB. Returns a 255 in A if the create failed.	
23 RENAME FILE	
INPUT: DE \leftarrow address of FCB RETURN: A \leftarrow directory code	
Renames a disk file. The name of the file is in the first 16 bytes of the FCB, the new name is in the next 16 bytes. Returns a 255 in A if the rename fails.	
24 RETURN LOGIN VECTOR	
INPUT: NONE RETURN: HL \leftarrow login vector	
Returns the disk login vector. The least significant bit of L represents Disk A and the next Drive B. When set to 1, the drive is on-line.	

Table 6.6 (Continued)

FUNCTION (Register C)	DESCRIPTION
--	--------------------

25 RETURN CURRENT DISK

INPUT: NONE

RETURN: A \leftarrow current disk number

Returns the number of the currently logged disk (0=A and 1=B).

26 SET DMA ADDRESS

INPUT: DE \leftarrow DMA address

RETURN: NONE

Sets the address of the 128-byte disk sector buffer.

27 GET ADDR (ALLOC)

INPUT: NONE

RETURN: HL \leftarrow ALLOC address

Returns the address of the allocation vector of the current disk.

28 WRITE PROTECT DISK

INPUT: NONE

RETURN: NONE

Protects the current disk from being written to.

Table 6.6 (Continued)

FUNCTION (Register C)	DESCRIPTION
--------------------------	-------------

29 GET READ ONLY VECTOR

INPUT: NONE

RETURN: HL ← read only vector

Returns a vector indicating which drives are temporarily write-protected. The least significant bit of L represents Disk A and the next Drive B. When set to 1, the drive is write-protected.

30 SET FILE ATTRIBUTES

INPUT: DE ← address of FCB

RETURN: A ← directory code

Sets read only and system file attributes.

31 GET ADDR (DISK PARMS)

INPUT: NONE

RETURN: HL ← address of DPB

Returns the address of the Disk Parameter Block.

32 SET/GET USER CODE

INPUT: E ← user code (SET)

E ← OFFH (GET)

RETURN: A ← user code (GET)

Table 6.6 (Continued)

FUNCTION (Register C)	DESCRIPTION
----------------------------------	--------------------

Returns or sets the current user code (user number).

33 READ RANDOM

INPUT: DE \leftarrow address of FCB

RETURN: A \leftarrow return code

Performs a random record read on a disk file. Return codes are:

- 01 reading unwritten data
- 03 cannot close current extent
- 04 seek to unwritten extent
- 06 seek past end of disk

34 WRITE RANDOM

INPUT: DE \leftarrow address of FCB

RETURN: A \leftarrow return code

Performs a random record write to a disk file. Return codes are:

- 01 reading unwritten data
- 03 cannot close current extent
- 04 seek to unwritten extent
- 05 out of directory space
- 06 seek past end of disk

Table 6.6 (Continued)

FUNCTION (Register C)	DESCRIPTION
--------------------------	-------------

35 COMPUTE FILE SIZE

INPUT: DE \leftarrow address of FCB

RETURN: file size

Returns the size of the file, in records, to the random record field of the FCB.

36 SET RANDOM RECORD

INPUT: DE \leftarrow address of FCB

RETURN: NONE

Sets the random record number of a record that was read sequentially. The random record number is placed into the random record field of the FCB.

37 RESET DRIVE

INPUT: DE \leftarrow drive vector

RETURN: NONE

Resets the disk drives indicated in the drive vector. The least significant bit of L represents Disk A and the next Drive B. When set to 1, the drive is reset.

38 NOT USED**39 NOT USED**

Table 6.6 (Continued)

FUNCTION (Register C)	DESCRIPTION
40 WRITE RANDOM WITH ZERO FILL	
INPUT: DE ← address of FCB	
RETURN: A ← return code	
Identical to WRITE RANDOM (Function 34), except that new blocks are zero-filled before data is moved into them.	

6.6 CALLING A Z80 PROGRAM FROM THE 6510

You sometimes may want to call a Z80 routine from your Commodore 64 while it is running in native mode. You may, for example, want to take advantage of the Z80 register structure or its extended instruction set, which make some routines easier to write or more efficient to execute.

When you first switch on your Z80 processor, it will *always* begin execution at its reset address:

6510 ADDRESS \$1000—Z80 ADDRESS \$0000

To call a Z80 routine from the 6510, you must either:

- Load the routine at 6510 address \$1000.
- Place a Z80 jump instruction at 6510 address \$1001 that transfers control to the actual code location.

In BOTH cases, 6510 address \$1000 (Z80 \$0000) must contain a **NOP instruction (\$00)**. This is a requirement of the processor switching hardware. Of course, if you place a jump instruction at 6510 address \$1001, you must load the actual Z80 routine elsewhere in memory.

On subsequent calls to the Z80, routine execution will resume at the instruction following the *last instruction executed* before the Z80 switched itself off. It does NOT resume execution at the reset address.

6.6.1 Some Examples

Suppose you load some Z80 code at 6510 address \$1000. You can transfer control to that code by switching on the Z80 processor:

```
LDA    #0      ;LOAD ZERO INTO A
STA    $DE00   ;STORE ZERO IN THE MODE SWITCH
                LOCATION
NOP                     ;REQUIRED BY THE SWITCH
                HARDWARE
```

The first time this code is executed, the Z80 will start executing instructions at \$0000 (6510 address \$1000); that address must contain a NOP instruction. Subsequent executions of the code (without turning off your Commodore 64) will cause the Z80 to resume execution where it left off when it switched the 6510 back on.

Assume now that you have loaded your Z80 code at 6510 address \$B000. This corresponds to a Z80 address of \$A000. You can get to this routine by using code similar to the following:

```
LDA    #$00    ;OPCODE FOR A NOP INSTRUCTION
STA    $1000   ;MEET THE SWITCHING
                REQUIREMENT
LDA    #$C3    ;Z80 JUMP INSTRUCTION OPCODE
STA    $1001   ;FIRST BYTE OF JUMP INSTRUCTION
LDA    #$00    ;LOW BYTE OF Z80 JUMP ADDRESS
STA    $1002   ;NEXT BYTE OF JUMP INSTRUCTION
LDA    #$A0    ;HIGH BYTE OF Z80 ADDRESS
STA    $1003   ;LAST BYTE OF JUMP INSTRUCTION
LDA    #0      ;LOAD ZERO INTO A
STA    $DE00   ;STORE ZERO IN THE MODE
                SWITCH LOCATION
NOP                     ;REQUIRED BY THE SWITCH
                HARDWARE
```

Subsequent executions of this code (without turning off your Commodore 64) will cause the Z80 to resume execution where it left off when it switched the 6510 back on. You could thus use address \$1000 for other purposes after calling the Z80 routine the first time.

You can return from your Z80 routine by using the code below:

```
MVI  A,1      ;LOAD ONE INTO A
STA  0CE00H   ;STORE ONE IN MODE SWITCH
                LOCATION
                ;TO TURN ON THE 6510
NOP          ;REQUIRED BY THE HARDWARE
                AFTER A MODESW

;
;THE NEXT TIME IT IS SWITCHED ON, THE Z80 RESUMES
EXECUTION HERE
;
```

NOTE: You MUST follow the mode switching store instruction with a NOP instruction.

6.7 CALLING A 6510 PROGRAM FROM THE Z80

There may be times when you want the 6510, running in Commodore 64 native mode, to perform some special tasks for you.

For example, suppose you add the IEEE expansion cartridge to your Commodore 64 in order to attach an IEEE standard instrument. Instruments require special control commands that can be issued only by the 6510 main processor.

The 6510 portion of the BIOS (BIOS65) includes a facility for calling your own code. This facility is implemented through the BIOS function codes 7, 8, and 9.

- BIOS function code 7 instructs BIOS65 to transfer control to:

6510 ADDRESS \$0E00—Z80 ADDRESS \$FE00

- BIOS function code 8 instructs BIOS65 to transfer control to:

6510 ADDRESS \$0F00—Z80 ADDRESS \$FF00

- BIOS function code 9 instructs BIOS65 to transfer control indirectly to the instruction whose address is stored at:

6510 ADDRESS \$0907—Z80 ADDRESS \$F907

The code that you load at these locations **MUST** end with a 6510 RTS instruction. This instruction returns control to BIOS65, which can then switch the Z80 processor back on.

As you see, function codes 7 and 8 always transfer control to the same location. If you use both functions 7 and 8, your programs cannot be larger than \$100 bytes (256 decimal). If you use only function code 7, you can expand your program into the function code 8 space. This gives you a maximum program size of \$200 bytes (512 decimal).

If you need more space than you can get under function codes 7 and 8, you can use function code 9. When you pass function code 9 to BIOS65, it transfers control to *the address* stored at 6510 location \$0F07. This address can be anywhere in the 6510 address space.

NOTE: When you use BIOS function 9, the indirect address you store at Z80 address \$FF07 (6510 address \$0F07) **MUST** be a 6510 base address.

6.7.1 Switching on the 6510

If you are going to use a 6510 routine, you have to know how to switch on the 6510 processor. The two processors

cannot operate at the same time. When you switch one of them on, the other is automatically switched off.

Processor switching is controlled by storing a *mode switch* value in:

6510 ADDRESS \$DE00—Z80 ADDRESS \$CE00

The *mode switch* values are:

- 0 → activates the Z80 processor
- 1 → activates the 6510 processor

Suppose you load some 6510 code at 6510 address \$0E00 that you wish to execute from a Z80 program. You can do that using code like the following:

```
MVI A,7          ;LOAD THE FUNCTION CODE INTO A
STA 0F900H       ;STORE THE FUNCTION CODE IN
                  COMMAND REGISTER
;
;               PREPARE ANY OTHER PARAMETERS
;               REQUIRED
;               BY THE CODE YOU HAVE
;               PLACED AT 6510 ADDRESS $0E00—Z80
;               ADDRESS $FE00
;
MVI A,1          ;LOAD ONE INTO A
STA 0CE00H       ;STORE ONE IN MODE SWITCH
                  LOCATION
;               ;TO TURN ON THE 6510
NOP              ;REQUIRED BY THE HARDWARE
                  AFTER A MODESW
;
;               AFTER COMPLETION OF THE 6510
;               ROUTINE, Z80 RESUMES
;               EXECUTION HERE
;
```

From the example above, you can see that it's easy to call a 6510 routine from the Z80. The 6510 routine that you write does not have to switch control back to the Z80. The BIOS65 program takes care of the return to the Z80.

NOTE: You **MUST** follow the mode-switching store instruction with a NOP instruction.

You must, of course, load your 6510 routine into the correct memory location before you transfer control to it. If you use BIOS function 9, you must also load the 6510 address of the code to be executed in indirect address location \$F907 (Z80).

6.8 PROGRAM EXECUTION UNDER CP/M

Programs destined to execute under CP/M must be stored in a disk file and have a file name extension of **.COM** (see Chapter 5 for an explanation of CP/M file-naming conventions and details on executing programs). User programs running under CP/M are loaded into the **Transient Program Area (TPA)** for execution.

You execute a program under CP/M simply by entering its name (without the extension). The general form is:

[DISKID:]PROGRAM-FILENAME

where *diskid* is an optional disk identifier (A or B) and *program-filename* is the name of the file that contains your program. The program file **MUST** have the extension **.COM**.

Suppose, for example, that you have a program stored in a file named **STARTREK.COM**. To execute that program, you respond to the CP/M prompt (usually **A>**) with:

STARTREK

CP/M will then load the file **STARTREK.COM** into the TPA (Transient Program Area) and transfer control to it (at location \$100). When **STARTREK** completes its execution, it returns to CP/M via a Z80 RET instruction or via a jump to location \$0000. The return via a jump to location \$0000 causes a warm start reboot of CP/M.

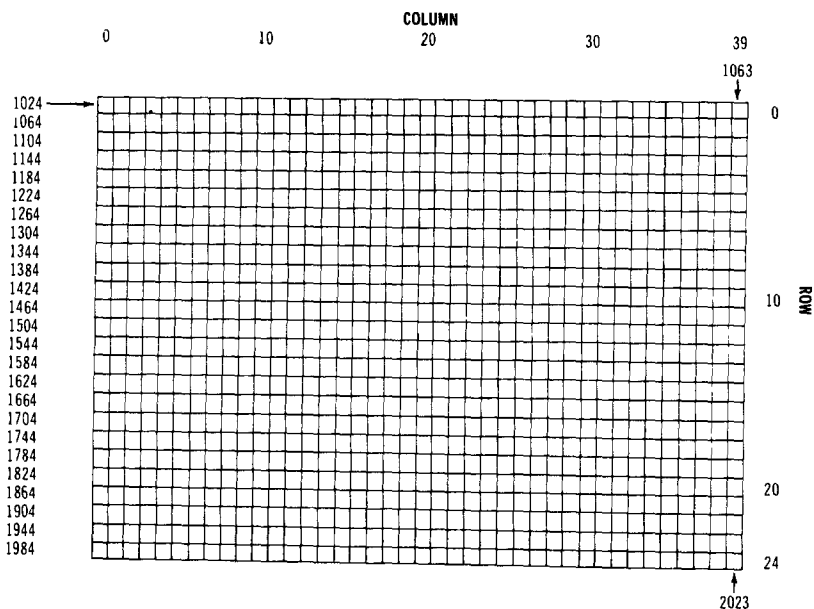
APPENDICES

APPENDIX A

COMMODORE 64 MEMORY MAP

The following charts list which memory locations control placing characters on the screen, and the locations used to change individual character colors, as well as showing character color codes.

SCREEN MEMORY MAP

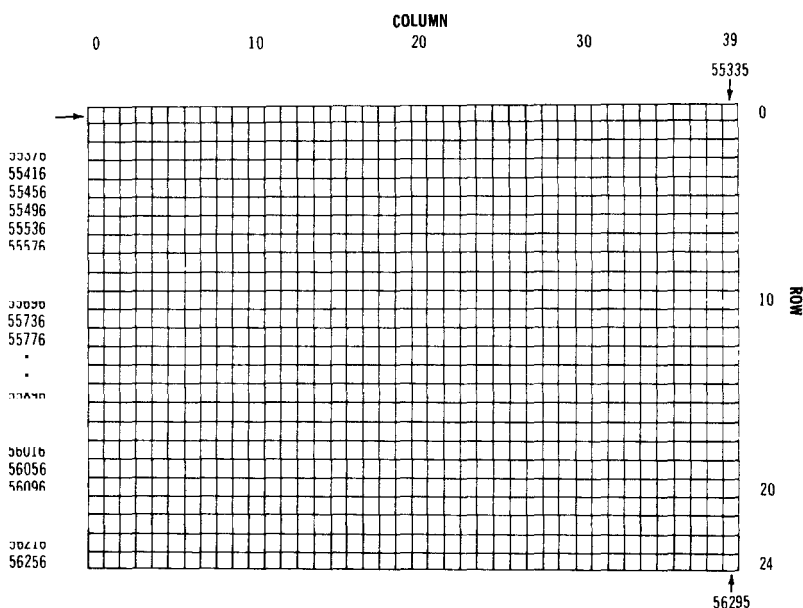


The actual values to POKE into a color memory location to change a character's color are:

0	BLACK	8	ORANGE
1	WHITE	9	BROWN
2	RED	10	Light RED
3	CYAN	11	GRAY 1
4	PURPLE	12	GRAY 2
5	GREEN	13	Light GREEN
6	BLUE	14	Light BLUE
7	YELLOW	15	GRAY 3

For example, to change the color of a character located at the upper left-hand corner of the screen to red, type: POKE 55296,2.

COLOR MEMORY MAP



APPENDIX B

BIBLIOGRAPHY

This bibliography lists a variety of currently available CP/M and Z80 books. Look at several books covering the topics that interest you before you make your selection.

Each author covers the topics from a different viewpoint. Find the book that you feel most comfortable with. Some people prefer a more technical discussion and should select a book with in-depth technical detail. Others like a less technical approach and should seek a book that is easy to understand.

You also can subscribe to a new magazine devoted exclusively to CP/M:

The User's Guide to CP/M Systems and Software
Box 3050
Stanford, CA 94305

You may be interested in joining the CP/M User's Group, which provides software written by members for their CP/M systems. Software is often available for only a copying charge. You can contact the CP/M User's Group through:

CP/M User's Group
c/o Lifeboat Associates
1651 Third Avenue
New York, NY 10028

B.1 CP/M Books

This list gives some of the most recent CP/M books in alphabetical order by title. It is by no means a list of all the CP/M books available today. The prices shown are subject to change.

CP/M Handbook With MP/M by Rodney Zaks, SYBEX, paper, \$14.95

This is a reference guide to CP/M, written in a readable style for beginners.

CP/M Primer by Stephen Murtha. Howard W. Sams, paper, \$14.95

This book helps both the first-time microcomputer user and the experienced user who is just beginning to use CP/M.

CP/M Word Processing by Chris DeVoney, Que Corporation, paper, \$16.50

This book covers the use of word processing packages developed to run under the CP/M operating system. It contains detailed evaluations of 17 popular CP/M word processing packages and tells how to decide which word processor best meets your needs.

How to Get Started with CP/M by Carl Townsend, Dillithium Press, paper, \$13.95

This book describes the CP/M operating system in an easy, comfortable style. It eases the reader into understanding the details of this widely used microcomputer operating system.

Osborne CP/M User Guide by Thom Hogan, Osborne, paper, \$12.99

One of the most complete and up-to-date CP/M books available. This book contains easy-to-understand descriptions of the CP/M operating system and commands. It also contains detailed technical information for more experienced users.

Using CP/M by Judi Fernandez and Ruth Ashley, John Wiley, paper, \$12.95

This is a complete, detailed introduction to the use of CP/M, written in an easy-to-understand style.

Vanloves CP/M Software Directory edited by Rolland Love and Gerald Van Diver, Vital Information, paper, \$24.95.

This up-to-date computer resource for CP/M describes peripherals, software, and accessories for CP/M systems. It includes a bibliography and lists of user groups, magazines, supplies, and computer accessories.

B.2 Z80 Books

8080/Z80 Assembly Language by Alan Miller, John Wiley, paper, \$10.95

A step-by-step guide to programming the 8080 and Z80 microprocessors. This book helps intermediate and advanced programmers to get even more out of their 8080/Z80.

Programming the Z80 by Rodnay Zaks, SYBEX, paper, \$15.95

This book covers the Z80 from basic concepts through advanced programming techniques. Exercises are offered to measure reader comprehension along the way. The book's topics range from hardware organizations to data structures.

Z80 and 8080 Assembly Language Programming by Kathe Spracklen, Hayden Book Co., paper, \$9.70

This book covers programming techniques and gives complete instruction sets for the 8080 and Z80 microprocessors. Each chapter includes exercises and answers to help readers learn to use the Z80 and 8080 more efficiently.

Z80 Microcomputer Design Projects by William Barden, Howard W. Sams, paper, \$13.95

This book gives a solid, in-depth look at the popular Z80 microprocessor. It provides a complete look at the internal architecture of the Z80.

Z80 Microcomputer Handbook by William Barden, Howard W. Sams, paper, \$11.95

This book is designed to teach you about the Z80. There is extensive coverage of Z80 machine language and the Z80 assembler language.

Z80 Microcomputer Programming and Interfacing, Books 1 and 2 by Elizabeth Nichols, Howard W. Sams, paper, Book 1—\$12.95, Book 2—\$12.95, Book 1 & 2—\$24.95

Book 1 introduces computers to readers who have no background in computer science. Book 2 assumes a familiarity with Book 1 and continues an in-depth discussion of the design and use of the popular Z80 microprocessor. Both volumes are written in a self-teaching format with exercises and answers.

Z80 User's Manual by Joseph Carr, Prentice-Hall, paper, \$15.95

An all-in-one guide to the Z80. This book is useful for both beginning and advanced Z80 users. It includes in-depth technical details for the Z80.

APPENDIX C

CP/M COMMAND LIST

This appendix is a simple listing of CP/M commands. For details on these commands, see Chapter 5.

Load and execute a program:

[disk-id:]filename <CR>

Change the currently logged disk:

disk-id:

Assemble a Z80 assembler program:

ASM filename[.parms]

ASM error codes are given in Table 5.4.

Run the CP/M debugger:

DDT [[disk-id:]filename.type]

DDT commands are given in Table 5.5.

Get a directory listing:

DIR [disk-id:]filename.type]

Dump a file in ASCII and hexadecimal format:

DUMP [disk-id:]filename.type

Edit a file:

ED [*disk-id:*]*filename*[*.type*] [[*disk-id2:*]
[*filename2*[*.type2*]]]

ED control characters are given in Table 5.8.

ED commands are given in Table 5.9.

Erase a file:

ERA [*disk-id:*]*filename.type*

Create an executable module from ASM output:

LOAD [*disk-id:*]*filename*

Copy a new version of CP/M:

MOVCP [{ * | *size* }] [*]

Copy a file or disk:

PIP *destination*=*source*[*command-parameters*]

Table 5.10 gives PIP logical devices.

Table 5.11 gives special PIP devices.

Table 5.12 gives PIP command parameters.

Rename a file:

REN [*disk-id:*] *new-file* = *old-file*

Save *page-num* 256-byte pages of memory beginning at the start of the TPA (100 hexadecimal):

SAVE *page-num* [*disk-id:*] *filename*[*.type*]

Get disk and I/O device status information:

STAT *command*

Table 5.13 shows STAT command options.

Table 5.14 shows STAT command attributes.

Submit a file for batch execution:

SUBMIT [*disk-id:*]*filename* [*parameters*]

Generate a new CP/M system:

SYSGEN [[*disk-id:*]*filename.type*]

Print a file to the screen:

TYPE [*disk-id:*] *filename.type*

Change the user number:

USER [*user-num*]

Include keyboard data in your SUBMIT file:

XSUB

APPENDIX D

ASCII, CHR\$, AND HEXADECIMAL CHARACTER CODES

When running in *native mode* your Commodore 64 uses two sets of character codes:

- CHR\$ Codes (see Appendix F of your Commodore 64 User's Guide).
- Screen Display Codes (see Appendix E of your Commodore 64 User's Guide).

CP/M employs another character code set called the **ASCII Character Codes** (shown in Table D.1 below).

NOTE: The CTRL-Shifted column of Table D.1 shows the values generated when you hold the **CTRL** key down and press the character key.

When you use the CONFIG utility to alter character code values, you must supply the ASCII *hexadecimal* value of the new character. Therefore, the character code values shown in Table D.1 are expressed in hexadecimal.

If you're not sure what a hexadecimal value is, don't worry. Look up the character in Table D.1 and use the value shown (including the letters).

Table D.1 ASCII Character Codes (Hexadecimal Values)

CHARACTER	HEX VALUE	CTRL SHIFTED
RUN/STOP	03	03
INS/DEL	08	18
RETURN	0D	0D
CLR/HOME	1B	7F
LEFT/RIGHT	1C/1D	1D
UP/DOWN	1E/1F	1F
SPACE	20	20

Table D.1 (Continued)

CHARACTER	HEX VALUE	CTRL SHIFTED
!	21	21
"	22	22
#	23	23
\$	24	24
%	25	25
&	26	26
'	27	27
(28	28
)	29	29
*	2A	2A
+	2B	2B
,	2C	7B
-	2D	2D
.	2E	7D
/	2F	5C
0	30	00
1	31	31
2	32	32
3	33	33
4	34	34
5	35	35
6	36	36
7	37	37
8	38	7B
9	39	7D
:	3A	7B
;	3B	7D
[40	60
a	41	01
b	42	02
c	43	03
d	44	04
e	45	05
f	46	06
g	47	07
h	48	08
i	49	09
j	4A	0A

Table D.1 (Continued)

CHARACTER	HEX VALUE	CTRL SHIFTED
k	4B	0B
l	4C	0C
m	4D	0D
n	4E	0E
o	4F	0F
p	50	10
q	51	11
r	52	12
s	53	13
t	54	14
u	55	15
v	56	16
w	57	17
x	58	18
y	59	19
z	5A	1A
[5C	7C
]	5E	7E
←	5F	5F
A	61	01
B	62	02
C	63	03
D	64	04
E	65	05
F	66	06
G	67	07
H	68	08
I	69	09
J	6A	0A
K	6B	0B
L	6C	0C
M	6D	0D
N	6E	0E
O	6F	0F
P	70	10
Q	71	11
R	72	12
S	73	13

Table D.1 (Continued)

CHARACTER	HEX VALUE	CTRL SHIFTED
T	74	14
U	75	15
V	76	16
W	77	17
X	78	18
Y	79	19
Z	7A	1A
F1	80	81
F2	81	81
F3	82	83
F4	83	83
F5	84	85
F6	85	85
F7	86	87
F8	87	87

APPENDIX E

BIOS AND BOOT LISTINGS

This appendix gives the source listings for the BIOS and BOOT programs on the 6510 and the Z80.

Xerox to Commodore 64 Receive Utility

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```
0100 =      TPA      EQU      100H      ;START ADDRESS OF PROGRAM
005C =      FCB      EQU      005CH     ;FILE CONTROL BLOCK
0080 =      DMADDR   EQU      0080H     ;DMA ADDRESS
000D =      CR       EQU      0DH       ;CARRIAGE RETURN
0006 =      ACK      EQU      06H
0015 =      NAK      EQU      15H
0000 =      BOOT     EQU      0000H
0005 =      BDOS     EQU      0005H
0E00 =      SIO      EQU      0E00H
FF00 =      MEM      EQU      0FF00H    ;BUFFER MEMORY
0300 =      PGM65    EQU      0300H
0080 =      SIZE65   EQU      128

;
;      SYNTAX FOR COMMAND IS
;
;      RECEIVE FILENAME.EXT
;
0100      ORG      TPA
;
0100 31D802      LXI      SP,STACK      ;SET UP LOCAL STACK
;
;      CHECK FOR VALID FILENAME
;
0103 113B02      LXI      D,NONAME ;NONAME MESSAGE
0106 3A5D00      LDA      FCB + 1
```

```

0109 FE20          CPI      ''
010B CAE201        JZ       DONE      ;IF SPACE, NO NAME GIVEN

;

010E 115802        LXI      D,BADNAM ;CHECK FOR AMBIGUOUS NAME
0111 215C00        LXI      H,FCB
0114 3E3F          MVI      A,'?'
0116 0610          MVI      B,16      ;COUNTER

;

0118 BE           QLOOP:    CMP     M      ,IS IT '?'
0119 CAE201        JZ       DONE      ;IF SO, BAD NAME

,

011C 23           INX       H
011D 05           DCR       B
011E C21801        JNZ      QLOOP      ;DO 16 TIMES

,

0121 118000        LXI      D,DMADDR
0124 CD1702        CALL     SETDMA

;

;          TRANSFER 6510 CODE TO $E00 (0FE00H)

,

;

;

0127 0680          MVI      B,SIZE65
0129 210003        LXI      H,PGM65
012C 1100FE        LXI      D,0FE00H

,

012F 78           MOV      A,B
0130 A7           ANA      A
0131 CA3C01        JZ       SKIP
0134 7E           LOADLP    MOV     A,M
0135 12           STAX     D
0136 23           INX      H
0137 13           INX      D
0138 05           DCR      B
0139 C23401        JNZ      LOADLP
;
;          GET READY BY OPENING FILES
;

013C 115C00        SKIP:    LXI      D,FCB
013F CD1D02        CALL     DELETE
0142 115C00        LXI      D,FCB
0145 CD2302        CALL     MAKE

;

```

0148	117602		LXI	D,NODIR	
014B	3C		INR	A	;WAS 255 IF NO FILE SPACE
014C	CAE201		JZ	DONE	
;					
014F	118000		LXI	D,DMADDR	
0152	CD1702		CALL	SETDMA	
;					
0155	AF	READS:	XRA	A	
0156	32B702		STA	POINT	
;					
;					
0159	3E06	GNEXT:	MVI	A,ACK	;SEND INITIAL ACK
015B	32FFFE	GBLK.	STA	0FEFFH	;I/O LOCATION
;					
015E	3E07		MVI	A,7	
0160	3200F9		STA	0F900H	
0163	3E01		MVI	A,1	
0165	3200CE		STA	0CE00H	
0168	00		NOP		
;					
;					
NEED TEST FOR ERROR					
;					
0169	3AFFFE		LDA	0FEFFH	
016C	A7		ANA	A	
016D	C2C401		JNZ	AGAIN	
;					
;					
0170	118000		LXI	D,DMADDR	
0173	3AB702		LDA	POINT	
0176	B3		ORA	E	
0177	5F		MOV	E,A	
0178	2100FF		LXI	H,MEM	
017B	7E		MOV	A,M	
017C	FE3A		CPI	' '	
017E	C2C401		JNZ	AGAIN	
;					
0181	AF		XRA	A	
0182	32B602		STA	BADDAT	
0185	CDE801		CALL	GYBTE	
0188	A7		ANA	A	
0189	CAD901		JZ	FINISH	

018C	FE20		CPI	32	
018E	C2C401		JNZ	AGAIN	
		;			
		;			
0191	0E00	GETQ:	MVI	C,0	;CHECKSUM
0193	47		MOV	B,Z	;COUNTER
		;			
0194	C5	GQLP:	PUSH	B	
0195	CDE801		CALL	GBYTE	
		;			
0198	12		STAX	D	
0199	1C		INR	E	
019A	C1		POP	B	
019B	81		ADD	C	
019C	4F		MOV	C,A	
019D	05		DCR	B	
019E	C29401		JNZ	GQLP	
		;			
01A1	C5		PUSH	B	
01A2	CDE01		CALL	CBYTE	
01A5	C1		POP	B	
01A6	81		ADD	C	
01A7	C2C401		JNZ	AGAIN	
		;			
01AA	3AB602		LDA	BADDAT	
01AD	B7		ORA	A	
01AE	C2C401		JNZ	AGAIN	
		;			
		;			
01B1	3AB702		LDA	POINT	
01B4	C620		ADI	32	
01B6	32B702		STA	POINT	
01B9	FE80		CPI	128	
01BB	C25901		JNZ	GNEXT	
		;			
01BE	CDC901		CALL	SWRITE	
01C1	C35501		JMP	READS	
		;			
01C4	3E15	AGAIN:	MVI	A,NAK	
01C6	C35801		JMP	GBLK	
		;			

01C9 115C00	SWRITE:	LXI	D,FCB
01CC CD2902		CALL	WRITE
01CF 119502		LXI	D,DFULL
01D2 87		ORA	A
01D3 C2E201		JNZ	DONE
;			
01D6 C9		RET	
01D7 00		NOP	
01D8 00		NOP	
;			
01D9 115C00	FINISH:	LXI	D,FCB
01DC CD2F02		CALL	CLOSE
01DF 11A102		LXI	D,EOTRAN
;			
01E2 CD3502	DONE:	CALL	PRINT
01E5 C30000		JMP	BOOT
;			
;			
;			
01E8 CDF501	GBYTE:	CALL	GNIB
01EB 87		ADD	A
01EC 87		ADD	A
01ED 87		ADD	A
01EE 87		ADD	A
01EF 47		MOV	B,A
01F0 CDF501		CALL	GNIB
01F3 80		ADD	B
01F4 C9		RET	
;			
01F5 23	GNIB:	INX	H
01F6 7E		MOV	A,M
01F7 FE30		CPI	'0'
01F9 DA1102		JC	NOTHEX
01FC FE3A		CPI	'9' + 1
01FE DA0E02		JC	NUMBER
0201 FE41		CPI	'A'
0203 DA1102		JC	NOTHEX
0206 FE47		CPI	'F' + 1
0208 D21102		JNC	NOTHEX
;			
020B D637	ALPHA:	SUI	'A'-10

020D C9		RET	
;			
020E D630	NUMBER:	SUI	0'
0210 C9		RET	
;			
0211 3EFF	NOTHEX:	MVI	A,OFFH
0213 32B602		STA	BADDAT
0216 C9		RET	
;			
;			
;			
0217 0E1A	SETDMA:	MVI	C,26
0219 CD0500		CALL	BDOS
021C C9		RET	
;			
021D 0E13	DELETE:	MVI	C,19
021F CD0500		CALL	BDOS
0222 C9		RET	
;			
0223 0E16	MAKE.	MVI	C,22
0225 CD0500		CALL	BDOS
0228 C9		RET	
;			
0229 0E15	WRITE:	MVI	C,21
022B CD0500		CALL	BDOS
022E C9		RET	
;			
022F 0E10	CLOSE.	MVI	C,16
0231 CD0500		CALL	BDOS
0234 C9		RET	
;			
;			
0235 0E09	PRINT.	MVI	C,9
0237 CD0500		CALL	BDOS
023A C9		RET	
;			
023B 46494C454E	NONAME:	DB	'FILENAME MUST BE SPECIFIED',ODH,ODH,'\$'
;			
0258 414D424947	BADNAM:	DB	'AMBIGUOUS FILES NOT ALLOWED',ODH,ODH,'\$'

```

0276 4E4F204449 NODIR: DB 'NO DIRECTORY SPACE AVAILABLE'
0292 0D0D24 DB ODH,ODH,'$'
;
0295 4449534B20 DFULL: DB 'DISK FULL'
029E 0D0D24 DB ODH,ODH,'$'
;
;
02A1 5452414E53 EOTRAN: DB 'TRANSFER COMPLETE.',ODH,ODH,'$'
;
02B6 BADDAT: DS 1
02B7 POINT: DS 1
;
02B8 DS 32
02DB = STACK EQU $

```

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```

0100 ORG 100H
;
; EQUATES
;
F800 = BUFFER EQU 0F800H
F900 = CMD EQU 0F900H
F901 = DATA EQU 0F901H
F902 = SECTOR EQU 0F902H
F903 = TRACK EQU 0F903H
F904 = DISKNO EQU 0F904H
0001 = OFF EQU 1
CE00 = MODESW EQU 0CE00H
0000 = VICRD EQU 0
0001 = VICWR EQU 1
0006 = VICFMT EQU 6
0005 = BDOS EQU 0005H
0000 = BOOT EQU 0000H
000D = CR EQU ODH ;CARRIAGE RETURN
000A = LF EQU 0AH ;LINE FEED

```

000C	=	CLS	EQU	OCH	;CLEAR SCREEN
		;			
0100	316B06	START:	LXI	SP,STACK	
0103	111403		LXI	D,COPMSG	
0106	CD0503	;	CALL	PRINT	;PROGRAM NAME, ETC.
0109	CD0003	INITO4:	CALL	CONIN	
		;			
010C	FE31		CPI	'1'	
010E	CA2301		JZ	FORMAT	
		;			
0111	FE32		CPI	'2'	
0113	CAD701		JZ	BACKUP	
		;			
0116	FE33		CPI	'3'	
0118	CA7B01		JZ	SYSTEM	
		;			
011B	FE34		CPI	'4'	
011D	CA0000		JZ	BOOT	
		;			
0120	C30901		JMP	INITO4	
		;			
0123	11A603	FORMAT	LXI	D,FMTMSG	;FORMAT A DISK
0126	CD0503		CALL	PRINT	
		;			
0129	CDD802		CALL	CRORRS	;GET KEYBOARD INPUT
012C	CA0001		JZ	START	;IF RUN/STOP, GO TO MENU
		;			
012F	116104		LXI	D,FMTING	;FORMATTING MESSAGE
0132	CD0503		CALL	PRINT	
		;			
0135	3E06		MVI	A,VICFMT	
0137	CD0A03		CALL	IO6510	;SEND FORMAT COMMAND TO 6510
		;			
013A	3A01F9		LDA	DATA	;CHECK FOR ERROR
013D	A7		ANA	A	
013E	C27501		JNZ	FMERR	
		;			
0141	2100F8		LXI	H,BUFFER	;FILL DISK BUFFER WITH E5's
0144	3EE		MVI	A,0E5H	; FOR DIRECTORY SECTORS
0146	77	FMT0:	MOV	M,A	

0147 2C		INR	L	
0148 C24601		JNZ	FMT0	;DO THIS 256 TIMES
	;			
014B 3E03		MVI	A,3	
014D 3203F9		STA	TRACK	;DIRECTORY TRACK
	;			
0150 3E00		MVI	A,0	
0152 3204F9		STA	DISKNO	;FORCE DRIVE 0
	,			
0155 3E00		MVI	A,0	;INITIAL SECTOR
	;			
0157 3202F9	FMT1:	STA	SECTOR	;SET SECTOR
015A 3E01		MVI	A,VICWR	;GET READY FOR WRITE
015C CD0A03		CALL	IO6510	;GO DO IT
015F 3A01F9		LDA	DATA	;A = 0 IF OK
0162 A7		ANA	A	
0163 C27501		JNZ	FMterr	
	;			
0166 3A02F9		LDA	SECTOR	
0169 3C		INR	A	
016A FE08		CPI	8	;DO ONLY SECTORS 0-7
016C C25701		JNZ	FMT1	;LOOP UNTIL DONE
	;			
016F 118704		LXI	D,FMTDON	
0172 C37502		JMP	DONE	
	;			
0175 119A04	FMterr:	LXI	D,FMterr	
0178 C37502		JMP	DONE	
	;			
017B 11D304	SYSTEM:	LXI	D,SYMSG	;SYSTEM TRACKS ONLY
017E CD0503		CALL	PRINT	
	;			
0181 112905		LXI	D,SRMSG	
0184 CD0503		CALL	PRINT	
	;			
0187 116905		LXI	D,PRMSG	
018A CD0503		CALL	PRINT	
018D CDD802		CALL	CRORRS	
\$190 CA0001		JZ	START	;IF SPACEBAR, GO TO MENU
	;			
0193 CDEA02		CALL	CRLF	

0196	216B06		LXI	H, MEM	;BEGINNING OF MEMORY SPACE ***
		;			
0199	3E01		MVI	A, 1	
019B	CD8402		CALL	RDTRK	;READ TRACK 1
		,			
019E	3E02		MVI	A, 2	
01A0	CD8402		CALL	RDTRK	;READ TRACK 2
		;			
01A3	3E12		MVI	A, 18	
01A5	CD8402		CALL	RDTRK	;READ TRACK 18
		,			
01A8	114905		LXI	D, DSTMSG	;PRINT DESTINATION MESSAGE
01AB	CD0503		CALL	PRINT	
		;			
01AE	110F06		LXI	D, RTNMSG	
01B1	CD0503		CALL	PRINT	
		,			
01B4	CD0003	SYS1.	CALL	CONIN	
01B7	FE0D		CPI	CR	;WAIT FOR CARRIAGE RETURN
01B9	C2B401		JNZ	SYS1	
		;			
01BC	CDEA02		CALL	CRLF	
		;			
01BF	216B06		LXI	H, MEM	;SETUP FOR WRITE ***
		;			
01C2	3E01		MVI	A, 1	
01C4	CDAE02		CALL	WRTRK	
		,			
01C7	3E02		MVI	A, 2	
01C9	CDAE02		CALL	WRTRK	
		;			
01CC	3E12		MVI	A, 18	
01CE	CDAE02		CALL	WRTRK	
		;			
01D1	118E05		LXI	D, SYSDON	
01D4	C37502		JMP	DONE	
		;			
01D7	11AC05	BACKUP:	LXI	D, BAKMSG	;BACKUP DISK
01DA	CD0503		CALL	PRINT	
		;			

01DD	116905		LXI	D,PRMSG	
01E0	CD0503		CALL	PRINT	
01E3	CDD802		CALL	CRORRS	
01E6	CA0001		JZ	START	
01E9	CDEA02		CALL	CRLF	
;					
01EC	3E01		MVI	A,1	;START WITH TRACK 1
01EE	3203F9		STA	TRACK	
;					
01F1	3E05		MVI	A,5	;DO OUTER LOOP 5 TIMES
01F3	324A06		STA	OUTER	
;					
01F6	3A03F9	BKLP;	LDA	TRACK	
01F9	324806		STA	WTRACK	;SAVE FOR WRITE TRACK
;					
01FC	3E07		MVI	A,7	
01FE	324906		STA	INNER	;INNER LOOP COUNTER
;					
0201	112905		LXI	D,SRMSG	
0204	CD0503		CALL	PRINT	
;					
0207	110F06		LXI	D,RTNMSG	
020A	CD0503		CALL	PRINT	
;					
020D	CD0003	BKRD1.	CALL	CONIN	
0210	FE0D		CPI	CR	
0212	C20D02		JNZ	BKRD1	
;					
0215	216B06		LXI	H,MEM	;START OF AVAILABLE MEMORY
,					
0218	3A03F9	BKRD:	LDA	TRACK	
021B	CD8402		CALL	RDTRK	
021E	3A03F9		LDA	TRACK	
0221	3C		INR	A	
0222	3203F9		STA	TRACK	
0225	3A4906		LDA	INNER	
0228	3D		DCR	A	
0229	324906		STA	INNER	
022C	C21802		JNZ	BKRD	
;					
022F	3A4806		LDA	WTRACK	

0232	3203F9		STA	TRACK	;RESTORE TRACK POINTER
0235	3E07		MVI	A,7	
0237	324906		STA	INNER	;INNER COUNTER
;					
023A	114905		LXI	D,DSTMSG	
023D	CD0503		CALL	PRINT	
0240	110F06		LXI	D,RTNMSG	
0243	CD0503		CALL	PRINT	
;					
0246	CD0003	BKWR1:	CALL	CONIN	
0249	FE0D		CPI	ODH	
024B	C24602		JNZ	BKWR1	
;					
024E	216B06		LXI	H,MEM	;START OF MEMORY AGAIN
;					
0251	3A03F9	BKWR:	LDA	TRACK	
0254	CDAE02		CALL	WRTRK	
0257	3A03F9		LDA	TRACK	
025A	3C		INR	A	
025B	3203F9		STA	TRACK	
025E	3A4906		LDA	INNER	
0261	3D		DCR	A	
0262	324906		STA	INNER	
0265	C25102		JNZ	BKWR	
;					
0268	214A06		LXI	H,OUTER	
026B	35		DCR	M	
026C	C2F601		JNZ	BKLP	
;					
;					
026F	11FC05		LXI	D,BAKDON	
0272	C37502		JMP	DONE	
;					
0275	CD0503	DONE.	CALL	PRINT	,PRINT DONE MESSAGE
;					
0278	11B804		LXI	D,ANYKEY	
027B	CD0503		CALL	PRINT	
027E	CD0003		CALL	CONIN	,WAIT FOR ANY KEY
0281	C30001		JMP	START	
;					
0284	3203F9	RDTRK:	STA	TACK	,A = TRACK ON ENTRY

0287	3E00		MVI	A,0	;START WITH SECTOR 0
;					
0289	3202F9	RD1:	STA	SECTOR	
028C	3E00		MVI	A,VICRD	;READ SECTOR COMMAND
028E	CD0A03		CALL	IO6510	;GO DO IT
0291	3A01F9		LDA	DATA	
0294	A7		ANA	A	
0295	C2FA02		JNZ	RDERR	,READ ERROR IF <>0
;					
0298	1100F8		LXI	D,BUFFER	
029B	1A	RD2:	LDAX	D	;GET CHARACTER FROM BUFFER
029C	77		MOV	M,A	; AND PUT IN MEMORY
029D	13		INX	D	
029E	23		INX	H	;BUMP POINTERS
029F	7B		MOV	A,E	;DONE 256 YET?
02A0	A7		ANA	A	
02A1	C29B02		JNZ	RD2	;JUMP IF NO
;					
02A4	3A02F9		LDA	• SECTOR	
02A7	3C		INR	A	
02A8	FE11		CPI	17	,17 = LAST SECTOR + 1
02AA	C28902		JNZ	RD1	
;					
02AD	C9		RET		
;					
02AE	3203F9	WRTRK:	STA	TRACK	;A = TRACK ON ENTRY
02B1	3E00		MVI	A,0	
;					
02B3	3202F9	WR1:	STA	SECTOR	
02B6	1100F8		LXI	D,BUFFER	
02B9	7E	WR2:	MOV	A,M	
02BA	12		STAX	D	,PUT CHAR IN BUFFER
02BB	23		INX	H	
02BC	13		INX	D	,INCREMENT POINTERS
02BD	7B		MOV	A,E	;DONE 256 YET?
02BE	A7		ANA	A	
02BF	C28902		JNZ	WR2	;JUMP IF NO
;					
02C2	3E01		MVI	A,VICWR	;SECTOR WRITE COMMAND
02C4	CD0A03		CALL	IO6510	;GO DO IT
;					

02C7 3A01F9		LDA	DATA	
02CA A7		ANA	A	
02CB C2F402		JNZ	WRERR	;JUMP IF WRITE ERROR
02CE 3A02F9		LDA	SECTOR	
02D1 3C		INR	A	
02D2 FE11		CPI	17	;17 = LAST SECTOR + 1
02D4 C2B302		JNZ	WR1	;KEEP READING
	;			
02D7 C9		RET		
	;			
02D8 FE20	CR1.	CPI	20H	;SPACEBAR?
02DA C8		RZ		
	;			
02DB CD0003	CORRRS-	CALL	CONIN	
02DE FE0D		CPI	CR	;CARRIAGE RETURN
02E0 C2DB02		JNZ	CR1	
	;			
02E3 A7		ANA	A	;KILL ZERO FLAG
02E4 C9		RET		
	;			
02E5 0E02	CONOUT:	MVI	C,2	
02E7 C30500		JMP	BDOS	
	;			
02EA 1E0D	CRLF:	MVI	E,CR	
02EC CDE502		CALL	CONOUT	
02EF 1E0A		MVI	E,LF	
02F1 C3E502		JMP	CONOUT	
	,			
02F4 111D06	WRERR:	LXI	D,WRMSG	
02F7 C37502		JMP	DONE	
	;			
02FA 113306	RDERR:	LXI	D,RDMSG	
02FD C37502		JMP	DONE	
	;			
0300 0E01	CONIN:	MVI	C,1	
0302 C30500		JMP	BDOS	
	;			
0305 0E09	PRINT:	MVI	C,9	
0307 C30500		JMP	BDOS	
	,			
030A 3200F9	IO6510:	STA	CMD	,PUT A IN 6510 COMMAND REGISTER

030D	3E01	MVI	A,OFF
030F	3200CE	STA	MODESW ;TURN OFF Z80
0312	00	NOP	
0313	C9	RET	
			TEXT AND MESSAGES:
0314	0C0A434F4D	COPMSG-	DB CLS,LF,'COMMODORE 04 UTILITY 1 0'
0333	0D0A0A	DB	CR,LF,LF
0336	2020312E20	DB	1. FORMAT DISK',CR,LF
0349	2020322E20	DB	' 2. BACKUP DISK',CR,LF
035C	2020332E20	DB	' 3. COPY SYSTEM TRACKS ONLY',CR,LF
037B	2020342E20	DB	' 4. EXIT',CR,LF,LF
0388	504C454153	DB	'PLEASE CHOOSE FUNCTION (1-4) \$'
03A6	0C0A464F52	FMTMSG:	DB CLS,LF,'FORMAT DISK UTILITY',CR,LF,LF
03BE	494E495449	DB	'INITIALIZES DISK FOR CP/M',CR,LF
03D9	0A43415554	DB	LF,'CAUTION! FORMAT ERASES ALL
			DATA',CR,LF,LF
03FD	504C414345	DB	'PLACE DISK TO BE FORMATTED IN',CR,LF
041C	4452495645	DB	'DRIVE 0 AND PRESS ENTER',CR,LF,LF
0436	202020204F	DB	' OR',CR,LF,LF
043F	5052455353	DB	'PRESS SPACEBAR TO RETURN TO MENU \$'
0461	0D0A0A464F	FMTING:	DB CR,LF,LF,'FORMATTING DISK, PLEASE WAIT...'
0483	0D0A0A24	DB	CR,LF,LF,'\$'
0487	464F524D41	FMTDON:	DB 'FORMAT COMPLETE',CR,LF,LF,'\$'
049A	492043414E	FMTERM:	DB 'I CANNOT FORMAT THIS DISK!',CR,LF,LF,'\$'
04B8	5052455353	ANYKEY:	DB 'PRESS ANY KEY TO CONTINUE \$'
04D3	0C0A535953	SYSMSG-	DB CLS,LF,'SYSTEM TRACK COPY UTILITY',CR,LF,LF
04F1	434F504945	DB	'COPIES SYSTEM TRACKS FROM MASTER
			DISK',CR,LF
0518	544F20534C	DB	'TO SLAVE DISK',CR,LF,LF,'\$'
0529	494E534552	SRCMSG:	DB 'INSERT MASTER DISK IN DRIVE 0',CR,LF,'\$'
0549	494E534552	DSTMSG:	DB 'INSERT SLAVE DISK IN DRIVE 0',CR,LF,'\$'

```

0569 5052455353 PRMSG: DB 'PRESS RETURN (OR SPACEBAR FOR MENU) $'
;
058E 5359535445 SYSDON: DB 'SYSTEM TRACK COPY COMPLETE',CR,LF,LF,$
;
05AC 0C0A444953 BAKMSG: DB CLS,LF,'DISK BACKUP UTILITY',CR,LF,LF
05C4 5448452045 DB 'THE ENTIRE MASTER DISK IS ',CR,LF
05E0 434F504945 DB 'COPIED TO THE SLAVE DISK',CR,LF,LF
05FB 24 DB '$'
;
05FC 4241434B55 BAKDON: DB 'BACKUP COMPLETE',CR,LF,LF,'$'
;
060F 5052455353 RTNMSG: DB 'PRESS RETURN $'
;
061D 0D0A0A4449 WRMSG: DB CR,LF,LF,'DISK WRITE ERROR',CR,LF,'$'
;
0633 0D0A0A4449 RDMSG: DB CR,LF,LF,'DISK READ ERROR',CR,LF,'$'
;
0648 WTRACK DS 1
0649 INNER DS 1
064A OUTER DS 1
064B DS 32
066B = STACK QU $
066B = MEM EQU $ ;***

```

Z80 Bootstrap Routine for the Commodore 64

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This routine is loaded from Track 1, Sector 5 of the Commodore 64 CP/M disk by a routine in BIOS65.

The load address is 0000H (with respect to the Z80 CPU). When the Z80 is enabled this program loads the Z80 BIOS and CCP and BDOS into RAM and jumps to it.

```

3400 = CCP EQU 3400H
;CCP EQU 0000H ;FOR MAKING BOOT0.HEX
;CCP EQU 0100H ;FOR MAKING BOOT1.HEX
001C = NSECTS EQU 1CH

```

F903	=	TRACK	EQU	0F903H	
F902	=	SECTOR	EQU	0F902H	
F904	=	DISKNO	EQU	0F904H	
FCFF	=	IOTYPE	EQU	0FCFFH	;IO SETUP BYTE IN BIOS65
4A33	=	KYBDMD	EQU	CCP + 1633H	;CAPS LOCK FLAG
0000	=	VICRD	EQU	0	
F900	=	CMD	EQU	0F900H	
0001	=	OFF	EQU	01H	
CE00	=	MODESW	EQU	0CE00H	
F901	=	DATA	EQU	0F901H	
F800	=	BUFFER	EQU	0FB00H	
4A00	=	BOOT	EQU	CCP + 1600H	
;					
0000		ORG	0000H		;Z80 RESET LOCATION
;					
0000	00	NOP			;NOP REQUIRED FOR HARDWARE
0001	110034	LXI	D,CCP		;START OF LOAD ADDRESS
0004	3E00	MVI	A,0		
0006	3204F9	STA	DISKNO		;LOAD IN FROM DRIVE A
0009	2601	MVI	H,1		;READ BEGINNING TRK 1, SEC 6
000B	2E06	MVI	L,6		
000D	7C	LOAD1	MOV	A,H	
000E	3203F9		STA	TRACK	
0011	7D		MOV	A,L	
0012	3202F9		STA	SECTOR	
0015	3E00		MVI	A,VICRD	;SECTOR READ COMMAND
0017	3200F9		STA	CMD	
001A	3E01		MVI	A,OFF	
001C	3200CE		STA	MODESW	;TURN OFF SELF
001F	00		NOP		
0020	3A01F9		LDA	DATA	;WAS TRANSFER OK?
0023	B7		ORA	A	
0024	C20D00		JNZ	LOAD1	;JUMP IF NO
;					
;					
OUTPUT '*' TO SHOW LOADING					
;					
0027	3E2A		MVI	A,'*	
0029	3201F9		STA	DATA	
002C	3E03		MVI	A,3	
002E	3200F9		STA	CMD	
0031	3E01		MVI	A,OFF	

0033	3200CE	STA	MODESW
0036	00		NOP
		;	
		;	MOVE SECTOR TO MEMORY
		;	
0037	0100F8	LXI	B,BUFFER
003A	0A	LOAD2:	LDAX B
003B	12	STAX	D
003C	0C	INR	C
003D	1C	INR	E
003E	C23A00	JNZ	LOAD2
		;	
		;	UPDATE POINTERS
		;	

CP/M Version 2.2 System Relocator – 2/80

CP/M Relocator Program, Included with the Module To Perform the Move from 900H to the Destination Address

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Modified for Use on the Commodore 64

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0041		INR	D
0042	2C	INR	L
0043	7D	MOV	A,L
		;	
		;	CHECK FOR END OF TRACK
		;	
0044	FE11	CPI	17
0046	DA4C00	JC	LOAD3
0049	24	INR	H
004A	2E00	MVI	L,0

011E	C21801		JNZ	QLOOP	;DO 16 TIMES
;					
0121	118000		LXI	D,DMADDR	
0124	CD0D02		CALL	SETDMA	
,					
0127	3E07		MVI	A,07H	;1200 BAUD DATA
0129	D300		OUT	0	
;					
012B	3E18		MVI	A,18H	
012D	D306		OUT	6	
012F	210001		LXI	H,0100H	
0132	CD0602		CALL	SETUP	
0135	21C103		LXI	H,03CLH	
0138	CD0602		CALL	SETUP	
013B	214404		LXI	H,0444H	
013E	CD0602		CALL	SETUP	
0141	216805		LXI	H,0568H	
0144	CD0602		CALL	SETUP	
;					
0147	115C00		LXI	D,FCB	
014A	CD1302		CALL	OPEN	
014D	116002		LXI	D,NOFILE	
0150	3C		INR	A	;WAS 255 IF NO FILE
0151	CAA201		JZ	DONE	
,					
0154	CDFC01	WTACK:	CALL	SIN	;WAIT FOR INITIAL ACK
0157	FE06		CPI	ACK	
0159	C25401		JNZ	WTACK	
;					
015C	3E00	RDNEXT:	MVI	A,0	
015E	328F02		STA	POINT	;QUARTER SECTOR POINTER
;					
0161	115C00		LXI	D,FCB	
0164	CD1902		CALL	READ	
0167	B7		ORA	A	
0168	C28B01		JNZ	EOF	
;					
0168	CDA801	AGAIN:	CALL	SEND	;SEND 32 BYTES
;					
016E	CDFC01	WTANS:	CALL	SIN	
0171	FE15		CPI	NAK	

0173	CA6801		JZ	AGAIN	;BAD CHECKSUM, SEND AGAIN
		;			
0176	FE06		CPI	ACK	
0178	C26E01		JNZ	WTANS	;IF NOT ACK, KEEP WAITING
		;			
0178	3A8F02		LDA	POINT	;POINT TO QUARTER
017E	C620		ADI	32	
0180	328F02		STA	POINT	
0183	FE80		CPI	128	
0185	CA5C01		JZ	RDNEXT	;IF 0, READ ANOTHER SECTOR
		;			
0188	C36B01		JMP	AGAIN	;SEND NEXT QUARTER
		;			
0188	3E3A	EOF:	MVI	A,';	;OUTPUT START OF STRING
018D	CDF001		CALL	SOUT	
		;			
0190	3E30		MVI	A,'0'	
0192	CDF001		CALL	SOUT	
		;			
0195	3E30		MVI	A,'0'	
0197	CDF001		CALL	SOUT	
		;			
019A	3E0D		MVI	A,CR	
019C	CDF001		CALL	SOUT	
		;			
019F	117A02		LXI	D,EOTRAN	
		;			
01A2	CD1F02	DONE:	CALL	PRINT	
01A5	C30000		JMP	BOOT	
		;			
01A8	3E3A	SEND:	MVI	A,';	
01AA	CDF001		CALL	SOUT	
		;			
01AD	3E20		MVI	A,32	
01AF	CDD901		CALL	SHOUT	;NUMBER OF DATA BYTES
		;			
01B2	0E00		MVI	C,0	;CLEAR CHECKSUM
01B4	218000		LXI	H,DMADDR	
01B7	3A8F02		LDA	POINT	;POINT TO SECTOR QUARTER
01BA	B5		ORA	L	
01BB	6F		MOV	L,A	,OR DATA INTO LSB
		;			

01BC 79	SEND1:	MOV	A,C	;FORM CHECKSUM
01BD 86		ADD	M	
01BE 4F		MOV	C,A	
01BF 7E		MOV	A,M	;GET CHARACTER
	;			
01C0 E5		PUSH	H	;SAVE ADDRESS
01C1 CDD901		CALL	SHOUT	;OUTPUT HEX DIGITS
01C1 E1		POP	H	
	;			
01C5 2C		INR	L	;NEXT BYTE
01C6 7D		MOV	A,L	
01C7 E61F		ANI	1FH	;CHECK FOR MOD 32
01C9 C2BC01		JNZ	SEND1	;DO 32 TIMES
	;			
01CC 79		MOV	A,C	;FIX CHECKSUM
01CD EEFF		XRI	OFFH	
01CF 3C		INR	A	
01D0 CDD901		CALL	SHOUT	
	;			
01D3 3E0D		MVI	A,0DH	
01D5 CDF001		CALL	SOUT	
01D8 C9		RET		
	;			
01D9 F5	SHOUT:	PUSH	PSW	
01DA 0F		RRC		
01DB 0F		RRC		
01DC 0F		RRC		
01DD 0F		RRC		
01DE CDE201		CALL	SNOUT	;OUTPUT HIGH NIBBLE
	;			
01E1 F1		POP	PSW	
01E2 E60F	SNOUT:	ANI	0FH	;MASK OFF BITS
01E4 FE0A		CPI	10	
01E6 DAEE01		JC	SNUM	
01E9 C637		ADI	'A'-10	
01EB C3F001		JMP	SOUT	
	;			
01EE C630	SNUM:	ADI	'0'	
	;			
01F0 F5	SOUT:	PUSH	PSW	
01F1 DB06	SOUT1:IN		06H	;XEROX CHANNEL A CONTROL

01F3	E604		ANI	04H	
01F5	CAF101		JZ	SOUT1	
;					
01F8	F1		POP	PSW	
01F9	D304		OUT	04H	;XEROX CHANNEL A DATA
01FB	C9		RET		
;					
01FC	DB06	SIN:	IN	6	
01FE	E601		ANI	01H	
0200	CAFC01		JZ	SIN	
0203	DB04		IN	4	
0205	C9		RET		
;					
0206	7C	SETUP:	MOV	A,H	
0207	D306		OUT	6	
0209	7D		MOV	A,1	
020A	D306		OUT	6	
020C	C9		RET		
;					
020D	0E1A	SETDMA:	MVI	C,26	
020F	CD0500		CALL	BDOS	
0212	C9		RET		
;					
0213	0E0F	OPEN:	MVI	C,15	
0215	CD0500		CALL	BDOS	
0218	C9		RET		
;					
0219	0E14	READ:	MVI	C,20	
021B	CD0500		CALL	BDOS	
021E	C9		RET		
;					
021F	0E09	PRINT:	MVI	C,9	
0221	CD0500		CALL	BDOS	
0224	C9		RET		
;					
0225	46494C454E	NONAME:	DB	'FILENAME MUST BE SPECIFIED',ODH,ODH,'\$'	
;					
0242	414D424947	BADNAM:	D8	'AMBIGUOUS FILES NOT ALLOWED',ODH,ODH,'\$'	
;					
0260	492043414E	NOFILE:	DB	'I CANNOT FIND THAT FILE',ODH,ODH,'\$'	
;					

```

027A 5452414E53 EOTRAN: DB      'TRANSFER COMPLETE.',0DH,0DH,'$'
;
028F              POINT:  DS      1
;
0290              DS      32
02B0 =            STACK  EQU      $

```

I/O Configuration Utility for Commodore 64

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```

FC00 =            IOMEM  EQU      0FC00H
F800 =            BUFFER EQU      0F800H
FCFF =            IOTYPE EQU      0FCFFH
FC10 =            FNBASE EQU      0FC10H
FD00 =            KYBASE EQU      0FD00H
0001 =            VICWR  EQU      1
F900 =            CMD    EQU      0F900H
F901 =            DATA  EQU      0F901H
F902 =            SECTOR EQU      F902H
F903 =            TRACK  EQU      0F903H
F904 =            DISKNO EQU      0F904H
F905 =            KYCHAR EQU      0F905H
0033 =            KYBDMD EQU      33H
0001 =            CRPOS  EQU      1
F28D =            SHFTST EQU      0F28DH
0063 =            LASTKY EQU      63H
0066 =            MSGPTR EQU      66H
0009 =            CONINV EQU      09H
0001 =            OFF    EQU      01H
CE00 =            MODESW EQU      0CE00H
;
0000 =            BOOT   EQU      0000H
0005 =            BDOS   EQU      0005H
000C =            CLS    EQU      0CH
000D =            CR     EQU      0DH
000A =            LF     EQU      0AH
0100              ORG    EQU      100H
;

```

0100	318308	START:	LXI	SP,STACK	;INITIALIZE STACK PTR
0103	115E04		LXI	D,IOMSG	
0106	CD7101		CALL	PRINT	
0109	3AFFFC		LDA	IOTYPE	
010C	E601		ANI	01H	;# OF DISKS
010E	C631		ADI	'1'	,FORM ASCII
0110	5F		MOV	E,A	
0111	CD7601		CALL	CONOUT	
0114	11C204		LXI	D,PRTMSG	
0117	CD7101		CALL	PRINT	
011A	11D604		LXI	D,P1515	
011D	3AFFFC		LDA	IOTYPE	
0120	E602		ANI	02H	;CHECK PRINTER TYPE
0122	CA2801		JZ	ST1	;1515 IF = 0
0125	11DD04		LXI	D,P4022	;4022 IF = 1
0128	CD7101	ST1:	CALL	PRINT	
0128	11E404		LXI	D,CAPMSG	
012E	CD7101		CALL	PRINT	
0131	11FB04		LXI	D,ONMSG	;ASSUME ON
0134	3AFFFC		LDA	IOTYPE	
0137	E620		ANI	20H	;8IT 5
0139	CA3F01		JZ	ST2	
013C	110005		LXI	D,OFFMSG	
013F	CD7101	ST2:	CALL	PRINT	
0142	110605		LXI	D,MENU	
0145	CD7101		CALL	PRINT	
0148	CD7B01	ST3:	CALL	KEYIN	
0148	FE31		CPI	'1'	
014D	CA9201		JZ	CHGDRV	

0150	FE32		CPI	'2'	
0152	CA9D01		JZ	CHRPRT	
		;			
0155	FE33		CPI	'3'	
0157	CAB601		JZ	CHGCAP	
		;			
015A	FE34		CPI	'4'	
015C	CAC001		JZ	CHGFNC	
		,			
015F	FE35		CPI	'5'	
0161	CACD02		JZ	CHGKEY	
		;			
0164	FE36		CPI	'6'	
0166	CA1A04		JZ	SAVDSK	
		,			
0169	FE37		CPI	'7'	
016B	CA0000		JZ	BOOT	
		;			
016E	C34801		JMP	ST3	;NOT A VALID RESPONSE
		;			
0171	0E09	PRINT:	MVI	C,9	
0173	C30500		JMP	BDOS	
		;			
0176	0E02	CONOUT:	MVI	C,2	
0178	C30500		JMP	BDOS	
		;			
017B	1EFF	KEYIN:	MVI	E,0FFH	
017D	0E06		MVI	C,6	
017F	C30500		JMP	BDOS	
		;			
0182	2A0100	CONIN:	LHLD	BOOT + 1	
0185	2E09		MVI	L,CONINV	
0187	E9		PCHL		
		;			
0188	3200F9	IO6510:	STA	CMD	
018B	3E01		MVI	A,OFF	
018D	3200CE		STA	MODESW	
0190	00		NOP		
0191	C9		RET		
		,			
0192	3AFFFC	CHGDRV:	LDA	IOTYPE	

0195	EE01	XRI	01H	
0197	32FFFC	STA	IOTYPE	
019A	C30001	JMP	START	
;				
019D	21FFFC	CHGPRT: LXI	H,IOTYPE	
01A0	7E	MOV	A,M	
01A1	E602	ANI	02H	
01A3	CAAD01	JZ	CHGP1	
;				
01A6	7E	MOV	A,M	;GET IOTYPE
01A7	E6F1	ANI	0F1H	;CLEAR BITS FOR 1515 PRINTER
01A9	77	MOV	M,A	
01AA	C30001	JMP	START	
;				
01AD	7E	CHGP1: MOV	A,M	;GET IOTYPE
01AE	E6FB	ANI	0FBH	;CLEAR BIT 2
01B0	F60A	ORI	0AH	;SET BITS FOR 4Q22 PRINTER
01B2	77	MOV	M,A	
01B3	C30001	JMP	START	
;				
01B6	21FFFC	CHGCAP: LXI	H,IOTYPE	
01B9	7E	MOV	A,M	
01BA	EE20	XRI	20H	;INVERT BIT
01BC	77	MOV	M,A	
01BD	C30001	JMP	START	
;				
01C0	11707	CHGFNC: LXI	D,FNKMSG	
01C3	CD7101	CALL	PRINT	
;				
01C6	3E00	MVI	A,0	
01C8	325F08	STA	KYMODE	
01CB	11A007	FNNEXT: LXI	D,FM1	
01CE	CD7101	CALL	PRINT	
01D1	3A5F08	LDA	KYMODE	
01D4	C631	ADI	'1'	
01D6	5F	MOV	E,A	
01D7	CD7601	CALL	CONOUT	
01DA	11A407	LXI	D,FM2	
01DD	CD7101	CALL	PRINT	
;				
01E0	CDA802	CALL	CALCAD	
;				

01E3 7E	FN2	MOV	A,M
01E4 23		INX	H
01E5 FE20		CPI	20H
01E7 DAF301		JC	CONTRL
;			
01EA 5F		MOV	E,A
01EB E5		PUSH	H
01EC CD7601		CALL	CONOUT
01EF E1		POP	H
01F0 C3E301		JMP	FN2
;			
01F3 F5	CONTRL.	PUSH	PSW
01F4 1E22		MVI	E,'''
01F6 CD7601		CALL	CONOUT
01F9 F1		POP	PSW
01FA FE00		CPI	0
01FC CA0502		JZ	CRLF
;			
01FF 11A907		LXI	D,CRM
0202 CD7101		CALL	PRINT
0205 11AE07	CRLF:	LXI	CD,CRLFM
0208 CD7101		CALL	PRINT
;			
020B 215F08		LXI	H,KYMODE
020E 34		INR	M
020F 7E		MOV	A,M
0210 FE08		CPI	8
0212 C2CB01		JNZ	FNNEXT
;			
0215 11B107		LXI	D,FNINST
0218 CD7101		CALL	PRINT
,			
021B CD7B01	ASKAGN.	CALL	KEYIN
021E D631		SUI	'1'
0220 DA1B02		JC	ASKAGN
;			
0223 FE08		CPI	8
025 CA0001		JZ	START
0228 D21B02		JNC	ASKAGN
;			
022B 325F08		STA	KYMODE
;			

022E	111C08		LXI	D,FM3	
0231	CD7101		CALL	PRINT	
;					
0234	11A007		LXI	D,FM1	
0237	CD7101		CALL	PRINT	
;					
023A	3A5F08		LDA	KYMODE	;GET CURRENT FN #
023D	C631		ADI	'1'	;FORM ASCII
023F	5F		MOV	E,A	
0240	CD7601		CALL	CONOUT	
0243	11A407		LXI	D,FM2	
0246	CD7101		CALL	PRINT	
0249	CDA802		CALL	CALCAD	
024C	225D08		SHLD	KYADDR	
;					
024F	3E00		MVI	A,0	
0251	326208		STA	NUMCHR	
,					
0254	CD7B01	INLOOP:	CALL	KEYIN	
0257	FE0D		CPI	0DH	
0259	CA8502		JZ	ITSCR	
;					
025C	FE08		CPI	08H	
025E	CAB902		JZ	ITS85	
;					
0261	FE1A		CPI	1AH	
0263	CA9102		JZ	ITSCZ	
;					
0266	FE20		CPI	20H	
0268	DA5402		JC	INLOOP	
;					
026B	FE80		CPI	80H	
026D	D25402		JNC	INLOOP	
;					
0270	47		MOV	B,A	,SAVE CHAR
0271	3A6208		LDA	NUMCHR	
0274	FE0F		CPI	15	;IF ALREADY 15 CHAR,
0276	D25402		JNC	INLOOP	; NO ROOM FOR 00H
;					
0279	C5		PUSH	B	
027A	58		MOV	E,B	

027B	CD7601		CALL	CONOUT	
027E	C1		POP	B	
		;			
027F	CD9902		CALL	OUTPUT	
0282	C35402		JMP	INLOOP	,GO FOR MORE
		;			
0285	47	ITSCR:	MOV	B,A	;SAVE CHAR
0286	3A6208		LDA	NUMCHR	
0289	FE0F		CPI	15	;NO ROOM IF 15 CHAR
028B	D25402		JNC	INLOOP	
		;			
028E	CD9902		CALL	OUTPUT	
		;			
0291	0600	ITSCZ:	MVI	B,0	
0293	CD9902		CALL	OUTPUT	
0296	C3C001		JMP	CHGFNC	
		,			
0299	2A5D08	OUTPUT.	LHLD	KYADDR	
029C	3A6208		LDA	NUMCHR	
029F	3C		INR	A	
02A0	326208		STA	NUMCHR	
02A3	3D		DCR	A	
02A4	85		ADD	L	;ADD IN OFFSET
02A5	6F		MOV	L,A	
02A6	70		MOV	M,B	
02A7	C9		RET		
		;			
02A8	2110FC	CALCAD:	LXI	H,FNBASE	
02AB	1600		MVI	D,0	
02AD	3A5F08		LDA	KYMODE	
02B0	17		RAL		
02B1	17		RAL		
02B2	17		RAL		
02B3	17		RAL		
02B4	E6F0		ANI	0F0H	
02B6	5F		MOV	E,A	
02B7	19		DAD	D	
02B8	C9		RET		
		;			
02B9	3A6208	ITSBS:	LDA	NUMCHR	
02BC	FE00		CPI	0	

```

02BE CA5402          JZ      INLOOP      ;IF 0 JUST GO TO LOOP
;
02C1 3D             DCR      A
02C2 326208         STA      NUMCHR
02C5 326208         STA      NUMCHR
02C5 1E08           MVI      E,08H      ,BACKSPACE
02C7 CD7601         CALL     CONOUT
02CA C35402         JMP      INLOOP
;
;
;
02CD 114306         CHGKEY- LXI      D,KYINST
02D0 CD7101         CALL     PRINT
;
02D3 112F07         CK0.   LXI      D,PRMSG
02D6 CD7101         CALL     PRINT
;
02D9 CD8201         CALL     CONIN
02DC 2A0100         LHLD     BOOT + 1
02DF 2E33           MVI      L,KYBMD    ,UNSHIFT = 0, CAPS = 1
02E1 46             MOV      B,M
02E2 3A8DF2         LDA      SHFTST     ,GET MODIFIER STATUS
02E5 E601           ANI      01H        ,IS SHIFT KEY DOWN?
02E7 CAEC02         JZ       CK1        ,JUMP IF NO
;
02EA 0602           MVI      B,2        ,SHIFT = 2
02EC 3A8DF2         CK1.   LDA      SHFTST
02EF E604           ANI      04H        ,IS THE CONTROL KEY DOWN?
02F1 CAF602         JZ       CK2        ,JUMP IF NO
;
02F4 0603           MVI      B,3        ,CONTROL = 3
02F6 2A0100         CK2.   LHLD     BOOT + 1
02F9 2E63           MVI      L,LASTKY
02FB 7E             MOV      A,M
02FC 326008         STA      KYCHK      ,SAVE FOR EXIT TEST
02FF 87             ADD      A          ,*2
0300 87             ADD      A          ,*4
0301 80             ADD      B          ,ADD IN OFFSET
0302 2100FD         LXI      H,KYBASE
0305 85             ADD      L
0306 6F             MOV      L,A        ,HL NOW HAS ADDRESS OF KEY
;

```

0307	225D08	SHLD	KYADDR	;ADDRESS OF KEY
030A	78	MOV	A,B	,8 IS THE MODE
030B	325F08	STA	KYMODE	
;				
030E	2A0100	LHLD	BOOT + 1	
0311	2E66	MVI	L,MSGPTR	
0313	3600	MVI	M,0	
0315	23	INX	H	
0316	3600	MVI	M,0	,DISABLE MESSAGE MODE IF ANY
;				
0318	113C07	LXI	D,ISMSG	
031B	CD7101	CALL	PRINT	
;				
031E	2A5D08	LHLD	KYADDR	
0321	7E	MOV	A,M	;GET KEY CODE
0322	CD6A03	CALL	PHEX	, AND PRINT IN HEX
;				
0325	114107	LXI	D,INMSG	
0328	CD7101	CALL	PRINT	
;				
032B	3A5F08	LDA	KYMODE	
032E	115E07	LXI	D,UNSH	;UNSHIFT MODE IF 0
0331	FE00	CPI	0	
0333	CA4903	JZ	PMODE	
;				
0336	114607	LXI	D,CAPS	
0339	FE01	CPI	1	
033B	CA4903	JZ	PMODE	;CAPS MODE IF 1
,				
033E	114E07	LXI	D,SHIFT	
0341	FE02	CPI	2	
0343	CA4903	JZ	PMODE	;SHIFT MODE IF 2
,				
0346	115607	LXI	D,CONT	,MUST BE CONTROL MODE
;				
0349	CD7101	PMODE: CALL	PRINT	
,				
034C	116607	LXI	D,MODE	
034F	CD7101	CALL	PRINT	
;				
0352	CD8603	CALL	GHEX	
;				

0355	C26303		JNZ	ASGKEY	
					;
0358	3A6008		LDA	KYCHK	,NO CHARACTERS, 2 CR'S?
035B	FE01		CPI	CRPOS	,IS IT CR KEY POSITION?
035D	CA0001		JZ	START	,RESTART IF 2 CR'S
					;
0360	C3D302		JMP	CK0	;NEXT KEY
0363	2A5D08	ASGKEY.	LHLD	KYADDR	
0366	77		MOV	M,A	;PUT NEW CHARACTER IN MEMORY
0367	C3D302		JMP	CK0	
					;
036A	F5	PHEX:	PUSH	PSW	;SAVE CHARACTER
036B	0F		RRC		
036C	0F		RRC		
036D	0F		RRC		
036E	0F		RRC		
036F	CD7303		CALL	HEX	;PRINT TOP NIBBLE
					;
0372	F1		POP	PSW	;PRINT LOWER NIBBLE
					;
0373	E60F	HEX:	ANI	0FH	;4 BITS
0375	FE0A		CPI	10	;LETTER OR NUMBER?
0377	DA8003		JC	NUMBER	
					;
037A	C637		ADI	'A'-10	;MAKE HEX LETTER
037C	ff		MOV	E,A	
037D	C37601		JMP	CONOUT	
					;
0380	C630	NUMBER.	ADI	'0'	,MAKE ASCII NUMBER
0382	5F		MOV	E,A	
0383	C37601		JMP	CONOUT	
					;
0386	3E00	GHEX:	MVI	A,0	
0388	326208		STA	NUMCHR	
					;
038B	CD8201	GH0:	CALL	CONIN	
038E	FE0D		CPI	0DH	
0390	C2A503		JNZ	GH1	
					;
0393	3A6208		LDA	NUMCHR	

0396 FE00		CPI	0	
0398 C8		RZ		
	;			
0399 FE02		CPI	2	
039B C28B03		JNZ	GH0	
	;			
039E 3EFF		MVI	A,OFFH	
03A0 A7		ANA	A	
03A1 3A6108		LDA	HEXIN	
03A4 C9		RET		
	;			
03A5 FE08	GH1:	CPI	08H	
03A7 C2CA03		JNZ	GH4	,JUMP NOT BACKSPACE
	,			
03AA 3A6208		LDA	NUMCHR	
03AD FE00		CPI	0	
03AF CA8B03		JZ	GH0	
	;			
03B2 3D		DCR	A	
03B3 326208		STA	NUMCHR	
03B6 3A6108		LDA	HEXIN	
03B9 0F		RRC		
03BA 0F		RRC		
03BB 0F		RRC		
03BC 0F		RRC		
03BD E60F		ANI	0FH	
03BF 326108		STA	HEXIN	
03C2 1E08		MVI	E 08H	
03C4 CD7601		CALL	CONOUT	
03C7 C38B03		JMP	GH0	
	;			
03CA 47	GH4:	MOV	B,A	
03CB 3A6208		LDA	NUMCHR	
03CE FE02		CPI	2	
03D0 CA8B03		JZ	GH0	
	;			
03D3 78		MOV	A,B	
03D4 FE30		CPI	'0'	
03D6 DA8B03		JC	GH0	
03D9 FE3A		CPI	'9' + 1	
03DB DAFF03		JC	GOTNUM	
	;			

03DE	FE41		CPI	'A'
03E0	DA8803		JC	GH0
,				
03E3	FE47		CPI	'F' + 1
03E5	DAF203		JC	GOTLET
,				
03E8	FE61		CPI	'A'
03EA	DA8803		JC	GH0
,				
03ED	FE67		CPI	'F' + 1
03EF	D28803		JNC	GH0
;				
03F2	F5	GOTLET	PUSH	PSW
03F3	5F		MOV	E,A
03F4	CD7601		CALL	CONOUT
03F7	F1		POP	PSW
03F8	E60F		ANI	0FH
03FA	C609		ADI	9
03FC	C30504		JMP	MAKNUM
,				
03FF	F5	GOTNUM.	PUSH	PSW
0400	5F		MOV	E,A
0401	CD7601		CALL	CONOUT
0404	F1		POP	PSW
;				
0405	E60F	MAKNUM:	ANI	0FH
0407	47		MOV	B,A
0408	3A6108		LDA	HEXIN
0408	87		ADD	A
040C	87		ADD	A
040D	87		ADD	A
040E	87		ADD	A
040F	80		ADD	B
0410	326108		STA	HEXIN
;				
0413	216208		LXI	H,NUMCHR
0416	34		INR	M
0417	C38803		JMP	GH0
,				
,				
;				

045E	0C0A434F4D	IOMSG:	DB	CLS,LF,'COMMODORE 64 I/O CONFIGURATION UTILITY' CR,LF,LF
0489	5448452043		DB	'THE CURRENT I/O ASSIGNMENTS ARE:',CR,LF,LF
04AC	20204E554D		DB	' NUMBER OF DRIVES. \$'
04C2	0D0A	PRTMSG:	DB	CR,LF
04C4	2020505249		DB	' PRINTER TYPE: \$'
				;
04D6	313531350D	P1515:	DB	'1515',CR,LF,'\$'
04DD	343032320D	P4022	DB	'4022',CR,LF,'\$'
				;
04E4	2020494E49	CAPMSG:	DB	' INITIAL CAPS MODE. \$'
				;
04FB	4F4E0D0A24	ONMSG	DB	'ON',CR,LF,'\$'
0500	4F46460D0A	OFFMSG:	DB	'OFF',CR,LF,'\$'
				,
0506	0A0A	MENU.	DB	LF,LF
0508	444F20594F		DB	'DO YOU WISH TO-',CR,LF,LF
051A	2020312E20		DB	' 1. CHANGE NUMBER OF DISK DRIVES',CR,LF
053E	2020322E20		DB	' 2. CHANGE PRINTER TYPE',CR,LF
0559	2020332E20		DB	' 3. CHANGE INITIAL CAPS MODE',CR,LF
0579	2020342E20		DB	' 4. CHANGE FUNCTION KEY ASSIGNMENTS',CR,LF
05A0	2020352E20		DB	' 5. CHANGE KEY CODES',CR,LF
05BB	2020362E20		DB	' 6 SAVE CURRENT I/O SETUP ON DISK',CR,LF
05DE	2020372E20		DB	' 7. RETURN TO CP/M',CR,LF,LF
05F5	504C454153		DB	'PLEASE ENTER SELECTION (1-7) \$'
				;
0613	0D0A0A4449	WERMSG:	DB	CR,LF,LF,'DISK WRITE ERROR',CR,LF
0628	5052455353		DB	'PRESS ANY KEY TO CONTINUE \$'
0643	0C0A	KYINST:	DB	CLS,LF
0645	5052455353		DB	'PRESS KEY TO EXAMINE KEY CODE',CR,LF,LF
0665	544F204348		DB	'TO CHANGE KEY CODE, ENTER DATA IN',CR,LF
06B8	2020204845		DB	' HEXADECIMAL AFTER "CHANGE TO" ',CR,LF,LF
06AB	544F204558		DB	'TO EXIT KEY CODE MODE. TYPE "RETURN" '.CR,LF
06D1	2020205457		DB	' TWICE AFTER "PRESS KEY" ',CR,LF,LF
06EE	544F204845		DB	'TO KEEP CURRENT KEY CODE, TYPE',CR,LF

070E	2020202252		DB	' "RETURN" AFTER "CHANGE TO" ',CR,LF,LF
072E	24		DB	'\$'
;				
072F	0D0A505245	PRMSG:	DB	CR,LF,'PRESS KEY \$'
;				
073C	0D49532024	ISMSG:	DB	CR,'IS \$'
;				
0741	20494E2024	INMSG:	DB	' IN \$'
0746	4341505320	CAPS	DB	'CAPS \$'
074E	534849465	SHIFT:	DB	'SHIFT \$'
0756	434F4E5452	CONT.	DB	'CONTROL\$'
075E	554E534849	UNSH:	DB	'UNSHIFT\$'
0766	204D4F4445	MODE.	DB	' MODE — CHANGE TO \$'
;				
0779	0C0A544845	FNKMSG:	DB	CLS,LF,'THE FUNCTION KEY ASSIGNMENTS ARE ',CR,LF,LF
079F	24		DB	'\$'
07A0	20204624	FM1	DB	' F\$'
;				
07A4	3A20202224	FM2	DB	': "\$'
;				
07A9	3C43523E24	CRM	DB	'<CR>\$'
07AE	0D0A24	CRLFM	DB	CR,LF,'\$'
;				
07B1	0A454E5445	FNINST	DB	LF,'ENTER FUNCTION KEY NUMBER (1-8) ',CR,LF
07D3	2020544F20		DB	'TO CHANGE PRESET VALUES.',CR,LF,LF
07F0	454E544552		DB	'ENTER 9 TO LEAVE FUNCTION',CR,LF
080B	2020484559		DB	' KEY UTILITY. \$'
;				
081C	0D0A0A5459	FM3	DB	CR,LF,LF,'TYPE IN TEXT. USING "RETURN" ',CR,LF
083D	20204F5220		DB	' OR "CTRL-Z" AS TERMINATOR.',CR,LF,LF,'\$'
;				
085D		KYADDR	DS	2 ;KEYBOARD LOOKUP ADDRESS
085F		KYMODE	DS	1 ;KEYBOARD MODE
0860		KYCHK	DS	1
0861		HEXIN	DS	1
0862		NUMCHR	DS	1
0863			DS	32
0883	=	STACK	EQU	\$

SYSGEN – System Generation Program 8/79

System Generation Program, Version for MDS

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Modified for use on Commodore 64. The system sectors run linearly from Track 1 Sector to Track 2 Sector 16.

0022 =	NSECTS	EQU	34	,NO. OF SECTORS PER TRACK
0002 =	NTRKS	EQU	2	,LAST OS TRACK + 1
0003 =	NDISKS	EQU	3	,NUMBER OF DISK DRIVES
0080 =	SECSIZ	EQU	128	,SIZE OF EACH SECTOR
0007 =	LOG2SEC	EQU	7	,LOG 2 SECSIZ
0001 =	SKEW	EQU	1	,SECTOR SKEW FACTOR
,				
005C =	FCB	EQU	005CH	,DEFAULT FCB LOCATION
007C =	FCBCR	EQU	FCB + 32	,CURRENT RECORD LOCATION
0100 =	TPA	EQU	0100H	,TRANSIENT PROGRAM AREA
0900 =	LOADP	EQU	900H	,LOAD POINT FOR SYSTEM DURING LOAD/STORE
0005 =	BDOS	EQU	5H	,DOS ENTRY POINT
0000 =	BOOT	EQU	0	,JMP TO 'BOOT' TO REBOOT SYSTEM
0001 =	CONI	EQU	1	,CONSOLE INPUT FUNCTION
0002 =	CONO	EQU	2	,CONSOLE OUTPUT FUNCTION
000E =	SELF	EQU	14	,SELECT DISK
000F =	OPENF	EQU	15	,DISK OPEN FUNCTION
0014 =	DREADF	EQU	20	,DISK READ FUNCTION
,				
000A =	MAXTRY	EQU	10	,MAXIMUM NUMBER OF RETRIES ON EACH READ/WRITE
000D =	CR	EQU	0DH	,CARRIAGE RETURN
000A =	LF	EQU	0AH	,LINE FEED
0010 =	STACKSIZE	EQU	16	,SIZE OF LOCAL STACK
,				
0001 =	WBOOT	EQU		1

```

;
;ADDRESS OF WARM BOOT
(OTHER PATCH ENTRY
POINTS ARE COMPUTED RELATIVE
TO WBOOT)
;
0018 = SELDSK EQU 24 ;WBOOT + 24 FOR DISK SELECT
001B = SETTRK EQU 27 ;WBOOT + 27 FOR SET TRACK
FUNCTION
001E = SETSEC EQU ,,130 ;WBOOT + 30 FOR SET SECTOR
FUNCTION
0021 = SETDMA EQU 33 ;WBOOT + 33 FOR SET DMA
ADDRESS
0024 = READF EQU 36 ;WBOOT + 36 FOR READ
FUNCTION
0027 = WRITF EQU 39 ;WBOOT + 39 FOR WRITE
FUNCTION
;
0100 ORG TPA ;TRANSIENT PROGRAM AREA
0100 C32302 JMP START
0103 434F505952 DB 'COPYRIGHT @ 1978, DIGITAL RESEARCH '
;
0128 02 OST DB NTRKS ;OPERATING SYSTEM TRACKS
0129 22 SPT: DB NSECTS ;SECTORS PER TRACK (CAN BE
PATCHED)
;
GETCHAR:
; READ CONSOLE CHARACTER TO REGISTER A
012A 0E01CD0500 MVI C,CONIT ! CALL BDOS!
; CONVERT TO UPPER CASE BEFORE RETURN
012F FE61D8 CPI 'A' OR 20H ! RC ;RETURN IF BELOW LOWER CASE A
0132 FE7B CPI ('Z' OR 20H) + 1
0134 D0 RNC ;RETURN IF ABOVE LOWER CASE Z
0135 E65FC9 ANI 5FH! RET
;
PUTCHAR.
; WRITE CHARACTER FROM A TO CONSOLE
013B 5F0E02CD05 MOV E,A! MVI C,CONO! CALL BDOS! RET
;
CRLF. ;SEND CARRIAGE RETURN, LINE FEED
013F 3E0D MVI A,CR
0141 CD3801 CALL PUTCHAR
0144 3E0A MVI A,LF

```

```

0146 CD3801      CALL    PUTCHAR
0149 C9          RET

;
CRMSG: ;PRINT MESSAGE ADDRESSED BY H,L TIL ZERO
;WITH LEADING CRLF

014A E5CD3F01E1  PUSH H! CALL CRLF! POP H
;DROP THRU TO OUTMSG0

OUTMSG:

014F 7EB7C8      MOV A,M! ORA A! RZ
;
MESSAGE NOT YET COMPLETED

0152 E5CD3801E1  PUSH H! CALL PUTCHAR! POP H! INX H
015B C34F01      JMP     OUTMSG

;
SEL:
;
SELECT DISK GIVEN BY REGISTER A

015B 4F2A010011  MOV C,A! LHLD WBOOT! LXI D,SELDISK! DAD D! PCHL
;
TRK: ;SET UP TRACK

0164 2A0100      LHLD    WBOOT    ;ADDRESS OF BOOT ENTRY
0167 111B00      LXI     D,SETTRK ;OFFSET FOR SETTRK ENTRY
016A 19          DAD     D
016B E9          PCHL      ;GONE TO SETTRK
;
SEC: ;SET UP SECTOR NUMBER

016C 2A0100      LHLD    WBOOT
016F 111E00      LXI     D,SETSEC
0172 19          DAD     D
0173 E9          PCHL
;
DMA: ;SET DMA ADDRESS TO VALUE OF B,C

0174 2A0100      LHLD    WBOOT
0177 112100      LXI     D,SETDMA
017A 19          DAD     D
017B E9          PCHL
;
READ: ;PERFORM READ OPERATION

017C 2A0100      LHLD    WBOOT
017F 112400      LXI     D,READF
0182 19          DAD     D
0183 E9          PCHL
;
WRITE: ;PERFORM WRITE OPERATION

```

0184	2A0100	LHLD	WBOOT	
0187	112700	LXI	D,WRITE	
018A	19	DAD	D	
018B	0E00	MVI	C,0	,SET UP NORMAL SECTOR WRITE
018D	E9	PCHL		
;				
	DREAD:			;DISK READ FUNCTION
018E	0E14	MVI	C,DREADF	
0190	C30500	JMP	BDOS	
;				
	OPEN:			;FILE OPEN FUNCTION
0193	0E0FC30500	MVI	C,OPENF !	JMP BDOS
;				
	GETPUT			
,				
				GET OR PUT CP/M (RW = 0 FOR READ, 1 FOR WRITE)
;				
				DISK IS ALREADY SELECTED
,				
0198	21B008	LXI	H,LOADP-80H	,SET UP INITIAL DMADDR
019B	225204	SHLD		
,				
				CLEAR TRACK TO 00
;				
019E	3E00	MVI	A,0	,START WITH TRACK 0 + 1
01A0	324F04	STA	TRACK	
01A3	4F	MOV	C,A	
01A4	CD6401	CALL	TRK	,TRACK NUMBER TO BIOS
01A7	3E09	MVI	A,9	,SECTOR 10 (- 1)
01A9	325004	STA	SECTOR	
01AC	C3C301	JMP	RWSEC	
;				
	RWTRK:			;READ OR WRITE NEXT TRACK
01AF	214F04	LXI	H,TRACK	
01B2	34	INR	M	,TRACK = TRACK + 1
01B3	3A2801	LDA	OST	,NUMBER OF OPERATING SYSTEM TRACKS
01B6	BE	CMP	M	,= TRACK NUMBER ?
01B7	CA2202	JZ	ENDRW	,END OF READ OR WRITE
,				
,				
				OTHERWISE NOTDONE, GO TO NEXT TRACK
01BA	4E	MOV	C,M	,TRACK NUMBER
01BB	CD6401	CALL	TRK	,TO SET TRACK
01BE	3EFF	MVI	A,OFFH	,COUNTS 0, 1, . . . 33

01C0 325004	STA	SECTOR	,SECTOR INCREMENTED BEFORE READ OR WRITE
,			
	RWSEC:	;READ OR WRITE SECTOR	
01C3 3A2901	LDA	SPT	;SECTORS PER TRACK
01C6 215004	LXI	H,SECTOR	
01C9 34	INR	M	;TO NEXT SECTOR
01CA BE	CMP	M	;A = 34 AND M = 0 1 2 . 33 (USUALLY)
01CB CAAF01	JZ	RWTRK	;
01CE 2A5204	LHLD	DMADDR	;SET UP DMA FOR NEXT ADDR
01D1 118000	LXI	D,80H	;SECTOR SIZE
01D4 19	DAD	D	;DMADDR = DMADDR + 80H
01D5 225204	SHLD	DMADDR	
;			
; READ OR WRITE SECTOR TO OR FROM CURRENT DMA ADDR			
01D8 215004	LXI	H,SECTOR	
01DB 4E	MOV	C,M	;VALUE TO C READY FOR SELECT
01DC CD6C01	CALL	SEC	;SET UP SECTOR NUMBER
01DF 2A5204	LHLD	DMADDR	;BASE DMA ADDRESS FOR THIS TRACK
01E2 44	MOV	B,H	
01E3 4D	MOV	C,L	;TO BC FOR SEC CALL
01E4 CD7401	CALL	DMA	;DMA ADDRESS SET FROM B,C
; DMA ADDRESS SET, CLEAR RETRY COUNT			
01E7 AF	XRA	A	
01EB 325404	STA	RETRY	;SET TO ZERO RETRIES
,			
	TRYSEC:	;TRY TO READ OR WRITE CURRENT SECTOR	
01EB 3A5404	LDA	RETRY	
01EE FE0A	CPI	MAXTRY	;TOO MANY RETRIES?
01F0 DA0702	JC	TRYOK	
;			
; PAST MAXTRIES, MESSAGE AND IGNORE			
01F3 21C303	LXI	H ERRMSG	
01F6 CD4F01	CALL	OUTMSG	
01F9 CD2A01	CALL	GETCHAR	
01FC FE0D	CPI	CR	
01FE C20E03	JNZ	REBOOT	
;			

```

,          TYPED A CR, OK TO IGNORE
0201 CD3F01      CALL      CRLF
0204 C3C301      JMP       RWSEC
;
TRYOK:
;          OK TO TRY READ OR WRITE
0207 3C          INR       A
0208 325404      STA       RETRY      ;REDAY = RETRY + 1
020B 3A5104      LDA       RW        ;READ OR WRITE?
020E B7          ORA       A
020F CA1802      JZ        TRYREAD
;
;          MUST BE WRITE
0212 CD8401      CALL      WRITE
0215 C31B02      JMP       CHKRW      ;CHECK FOR ERROR RETURNS
TRYREAD:
0218 CD7C01      CALL      READ
CHKRW:
021B B7          ORA       A
021C CAC301      JZ        RWSEC      ;ZERO FLAG IF R/W OK
;
;          ERROR, RETRY OPERATION
021F C3EB01      JMP       TRYSEC
;
;
ENDRW. ;END OF READ OR WRITE, RETURN TO CALLER
0222 C9          RET
;
;
START.
;
0223 317504      LXI       SP,STACK  ;SET LOCAL STACK POINTER
0226 212003      LXI       H,SIGNON
0229 CD4F01      CALL      OUTMSG
;
;          CHECK FOR DEFAULT FILE LOAD INSTEAD OF GET
;
022C 3A5D00      LDA       FCB + 1   ;BLANK IF NO FILE
022F FE20        CPI       ''
0231 CA8102      JZ        GETSYS     ;SKIP TO GET SYSTEM MESSAGE
                                         IF BLANK

```

0234	115C00	LXI	D,FCB	;TRY TO OPEN IT
0237	CD9301	CALL	OPEN	;
023A	3C	INR	A	,255 BECOMES 00
023B	C24702	JNZ	RDOK	,OK TO READ IF NOT 255
				FILE NOT PRESENT, ERROR AND REBOOT
023E	212004	LXI	H,NOFILE	
0241	CD4A01	CALL	CRMSG	
0244	C30E03	JMP	REBOOT	
				FILE PRESENT
				READ TO LOAD POINT
				RDOK:
0247	AF	XRA	A	
0248	327C00	STA	FCBCR	,CURRENT RECORD = 0
				PRE-READ AREA FROM TPA TO LOADP
024B	0E10	MVI	C,(LOADP-TPA)/SECSIZ	
				PRE-READ FILE
				PRERD
024D	C5	PUSH	B	,SAVE COUNT
024E	115C00	LXI	D,FCB	,INPUT FILE CONTROL COUNT
0251	CD8E01	CALL	DREAD	,ASSUME SET TO DEFAULT BUFFER
0254	C1	POP	B	,RESTORE COUNT
0255	B7	ORA	A	
0256	C27B02	JNZ	BADRD	,CANNOT ENCOUNTER END-OF FILE
0259	0D	DCR	C	,COUNT DOWN
025A	C24D02	JNZ	PRERD	,FOR ANOTHER SECTOR
				SECTORS SKIPPED AT BEGINNING OF FILE
025D	210009	LXI	H,LOADP	
				RDINP:
0260	E5	PUSH	H	
0261	44	MOV	B,H	
0262	4D	MOV	C,L	,READY FOR DMA
0263	CD7401	CALL	DMA	,DMA ADDRESS SET


```

0266 115C00      LXI      D,FCB      ;READY FOR READ
0269 CD8E01      CALL     DREAD      ;
026C E1          POP      H          ;RECALL DMA ADDRESS
026D B7          ORA      A          ;00 IF READ OK
026E C2C702      JNZ      PUTSYS     ;ASSUME EOF IF NOT.
;              MORE TO READ, CONTINUE
0271 118000      LXI      D,SECSIZ
0274 19          DAD      D          ;HL IS NEW LOAD ADDRESS
0275 C36002      JMP      RDINP
;
BADRD:          ;EOF ENCOUNTERED IN INPUT FILE
0278 213704      LXI      H,BADFILE
027B CD4A01      CALL     CRMSG
027E C30E03      JMP      REBOOT
;
;
GETSYS:
0281 212F03      LXI      H,ASKGET   ;GET SYSTEM?
0284 CD4A01      CALL     CRMSG
0287 CD2A01      CALL     GETCHAR
028A FE0D        CPI      CR
028C CAC702      JZ       PUTSYS     ;SKIP IF CR ONLY
;
028F D641        SUI      'A'       ;NORMALIZE DRIVE NUMBER
0291 FE03        CPI      NDISKS    ;VALID DRIVE?
0293 DA9C02      JC       GETC      ;SKIP TO GETC IF SO
;
;              INVALID DRIVE NUMBER
0296 CD1903      CALL     BADDISK
0299 C38102      JMP      GETSYS     ;TO TRY AGAIN
;
GETC
;              SELECT DISK GIVEN BY REGISTER A
029C C641        ADI      'A'
029E 325F03      STA      GDISK     ;TO SET MESSAGE
02A1 D641        SUI      'A'
02A3 CD5B01      CALL     SEL        ;TO SELECT THE DRIVE
;              GETSYS, SET RW TO READ AND GET THE SYSTEM
02A6 CD3F01      CALL     CRLF
02A9 215503      LXI      H,GETMSG
02AC CD4F01      CALL     OUTMSG

```

```

02AF CD2A01      CALL    GETCHAR
02B2 FE0D        CPI      CR
02B4 C20E03      JNZ      REBOOT
02B7 CD3F01      CALL     CRLF

;

02BA AF          XRA      A
02BB 325104      STA      RW
02BE CD9801      CALL     GETPUT
02C1 21EA03      LXI      H,DONE
02C4 CD4F01      CALL     OUTMSG

;
;      PUT SYSTEM
PUTSYS:
02C7 217303      LXI      H,ASKPUT
02CA CD4A01      CALL     CRMSG
02CD CD2A01      CALL     GETCHAR
02D0 FE0D        CPI      CR
02D2 CA0E03      JZ       REBOOT
02D5 D641        SUI      'A'
02D7 FE03        CPI      NDISKS
02D9 DAE202      JC       PUTC

;
;      INVALID DRIVE NAME
02DC CD1903      CALL     BADDISK
02DF C3C702      JMP      PUTSYS      ,TO TRY AGAIN

;
;      PUTC.
;      SET DISK FROM REGISTER C
02E2 C641        ADI      'A'
02E4 32AF03      STA      PDISK      ,MESSAGE SET
02E7 D641        SUI      'A'
02E9 CD5B01      CALL     SEL        ,SELECT DEST DRIVE

;      PUT SYSTEM, SET RW TO WRITE
02EC 21A003      LXI      H,PUTMSG
02EF CD40A01     CALL     CRMSG
02F2 CD2A01      CALL     GETCHAR
02F5 FE0D        CPI      CR
02F7 C20E03      JNZ      REBOOT
02FA CD3F01      CALL     CRLF

;

02FD 215104      LXI      H,RW

```

0300	3601		MVI	M,1	
0302	CD9B01		CALL	GETPUT	;TO PUT SYSTEM BACK ON DISKETTE
0305	21EA03		LXI	H,DONE	
0308	CD4F01		CALL	OUTMSG	
030B	C3C702		JMP	PUTSYS	;FOR ANOTHER PUT OPERATION
,					
REBOOT:					
030E	3E00		MVI	A,0	
0310	CD5B01		CALL	SEL	
0313	CD3F01		CALL	CRLF	
0316	C30000		JMP	BOOT	
BADDISK:					
,BAD DISK NAME					
0319	21FC03		LXI	H,QDISK	
031C	CD4A01		CALL	CRMSG	
031F	C9		RET		
;					
;					
;					
;					
; DATA AREAS					
; MESSAGES					
0320	5359534745	SIGNON:	DB	'SYSGEN VER'	
032B	322E30		DB	VERS/0 + '0','.',VERS MOD 10 + '0'	
032E	00		DB	0	
032F	534F555243	ASKGET	DB	'SOURCE DRIVE NAME'	
0340	0D284F5220		DB	0DH, '(OR RETURN TO SKIP) ',0	
0355	534F555243	GETMSG:	DB	'SOURCE ON '	
035F		GDISK:	DS	1	;FILLED IN AT GET FUNCTION
0360	2C20544845		DB	', THEN TYPE RETURN',0	
0373	4445535449	ASKPUT	DB	'DESTINATION DRIVE NAME'	
0389	0D284F5220		DB	0DH, '(OR RETURN TO REBOOT) ',0	
03A0	4445535449	PUTMSG:	DB	'DESTINATION ON '	
03AF		PDISK:	DS	1	;FILLED IN AT PUT FUNCTION
03B0	2C20544845		DB	', THEN TYPE RETURN',0	
03C3	5045524D41	ERRMSG:	DB	'PERMANENT ERROR, TYPE RETURN TO IGNORE',0	
03EA	46554E4354	DONE:	DB	'FUNCTION COMPLETE',0	
03FC	494E56414C	QDISK:	DB	'INVALID DRIVE NAME (USE A, B, OR C) ',0	
0420	4E4F20534F	NOFILE	DB	'NO SOURCE FILE ON DISK',0	
BADFILE:					

```

0437 534F555243      DB      'SOURCE FILE INCOMPLETE',0
;
;      VARIABLES
044E      SDISK·      DS      1      ;SELECTED DISK FOR CURRENT
                                OPERATION
044F      TRACK:      DS      1      ;CURRENT TRACK
0450      SECTOR:      DS      1      ;CURRENT SECTOR
0451      RW:         DS      1      ;READ IF 0, WRITE IF 1
0452      DMADDR·      DS      2      ;CURRENT DMA ADDRESS
0454      RETRY:       DS      1      ;NUMBER OF TRIES ON THIS
                                SECTOR
0455                                DS      STACKSIZE*2
                                STACK:
0475                                END

```

Custom BIOS for CP/M 2.2 On Commodore 64

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This version has the following attributes:

1. Memory map set up for 52K RAM system with I/O and drivers by BOOT65
2. Disk tables and vectors included for 2 drives
3. The Intel I/O byte is not implemented
4. Punch and reader are null routines
5. Keyboard and message tables are part of BIOS65
6. A 20K to 48K byte CP/M environment can be supported on the Commodore 64 (44K with IEEE)
7. Virtual Drive B is supported for 1540
8. Drive B is not virtual on IEEE disk

```

0000 =      BASE      EQU      0000H      ;BEGINNING OF ADDRESSABLE
                                RAM
;
002C =      MSIZE      EQU      44      ;CP/M VERSION MEMORY SIZE IN
                                KILOBYTES
;
,      "BIAS" IS ADDRESS OFFSET FROM 3400H FOR MEMORY
                                SYSTEMS

```

```

,      THAN 20K (REFERRED TO AS "B" THROUGHOUT THE
      TEXT)
,
6000 =    BIAS    EQU    (MSIZE-20) *1024
,
,      NOTE: TO CREATE MOVCPM, THE FOLLOWING CCP
,      EQUATES ARE USED.
;
;CCP    EQU    0000H    ;FOR BIOS0.HEX
;CCP    EQU    0100H    ;FOR BIOS1.HEX
,
9400 =    CCP    EQU    3400H + BIAS    ;BASE OF CCP
9C06 =    BDOS    EQU    CCP + 806H    BASE OF BDOS
AA00 =    BIOS    EQU    CCP + 1600H    BASE OF BIOS
0004 =    CDISK    EQU    BASE + 0004H    CURRENT DISK NUMBER 0 = A,
,      . . . , 15 = P
0003 =    IOBYTE    EQU    BASE + 0003H    INTEL I/O BYTE
0000 =    TRANS    EQU    0000H    ;0 IMPLIES NO TRANSLATION
0005 =    ENTRY    EQU    0005H    ;BDOS ENTRY VECTOR
,
;
,      Z80 INSTRUCTIONS
;
0018 =    JR      EQU    18H
0038 =    JRC     EQU    38H
0030 =    JRNC    EQU    30H
0028 =    JRZ     EQU    28H
0020 =    JRNZ    EQU    20H
,
;
;      THE FOLLOWING EQUATES DEFINE THE COMMON
      MEMORY FOR PASSING DATA TO AND FROM THE 6510
;      I/O ROUTINES
;
F800 =    HSTBUF    EQU    0F800H    ;256 BYTE DISK BUFFER
F900 =    CMD      EQU    0F900H    ;COMMAND REGISTER
F901 =    DATA    EQU    0F901H    ;DATA REGISTER
F902 =    SECTOR    EQU    0F902H    ;SECTOR REGISTER
F903 =    TRACK    EQU    0F903H    ;TRACK REGISTER
F904 =    DISKNO    EQU    0F904H    ;DRIVE NUMBER REGISTER
F905 =    KYCHAR    EQU    0F905H    ;KEYBOARD CHARACTER
      REGISTER

```

```

FCFF =      IOTYPE EQU 0FCFFH ,IO CONFIGURATION BYTE
,
;      THE Z80 SHUTS ITSELF OFF BY WRITING "OFF" TO THE
;      LOCATION "MODESW"
,
0001 =      OFF EQU 1
CE00 =      MODESW EQU 0CE00H
,
;      THE FOLLOWING ARE THE COMMANDS TO THE 6510 I/O
;      ROUTINES
.
0000 =      VICRD EQU 0 ,READ SPECIFIED SECTOR
0001 =      VICWR EQU 1 ,WRITE SPECIFIED SECTOR
0002 =      VICIN EQU 2 ,DO A KEYBOARD SCAN
0003 =      VICOUT EQU 3 ,OUTPUT DATA TO SCREEG
0004 =      VICPST EQU 4 ,GET PRINTER STATUS
0005 =      VICPRT EQU 5 ,SEND CHARACTER TO PRINTER
0006 =      VICFMT EQU 6 ,FORMAT DISK COMMAND
0007 =      AUX1 EQU 7 ,JUMP TO $0E00 IN 6510 SPACE
0008 =      AUX2 EQU 8 ,JUMP TO $0F00 IN 6510 SPACE
0009 =      INDIR EQU 9 ,JUMP INDIRECT VIA 0F906
,
;
AA00 ,ORG BIOS ,ORIGIN OF THIS PROGRAM
0016 =      NSECTS EQU ($-CCP)/256 ,WARM START SECTOR COUNT
,
;      JUMP VECTOR FOR INDIVIDUAL SUBROUTINES
AA00 C36CAA ,JMP BOOT ,COLD START
AA03 C31DAB WBOOTE: JMP WBOOT ,WARM START
AA06 C39AAB ,JMP CONST ,CONSOLE STATUS
AA09 C3FEAB ,JMP CONIN ,CONSOLE CHARACTER IN
AA0C C376AC ,JMP CONOUT ,CONSOLE CHARACTER OUT
AA0F C3B1AC ,JMP LIST ,LIST CHARACTER OUT
AA12 C3FAAC ,JMP PUNCH ,PUNCH CHARACTER OUT
AA15 C3FDAC ,JMP READER ,READER CHARACTER OUT
AA18 C302AD ,JMP HOME ,MOVE HEAD TO HOME POSITION
AA1B C30CAD ,JMP SELDSK ,SELECT DISK
AA1E C320AD ,JMP SETTRK ,SET TRACK NUMBER
AA21 C326AD ,JMP SETSEC ,SET SECTOR NUMBER
AA24 C32BAD ,JMP SETDMA ,SET DMA ADDRESS
AA27 C334AD ,JMP READ ,READ RISK

```

AA2A C347AD	JMP	WRITE	;WRITE DISK
AA2D C3D1AC	JMP	LISTST	;RETURN LIST STATUS
AA30 C331AD	JMP	SECTTRAN	;SECTOR TRANSLATE
;			
AA33 00	KYBDMD-	DB	00H ;CAPS LOCK FLAG
;			
; FIXED DATA TABLES FOR TWO DRIVES			
; DISK PARAMETER HEADER FOR DISK 00			
AA34 00000000	DPBASE	DW	TRANS,0000H
AA38 00000000		DW	0000H,0000H
AA3C F0AE54AA		DW	DIRBF,DPBLK
AA40 AEA70AF		DW	CHK00,ALL00
; DISK PARAMETER HEADER FOR DISK 01			
AA44 00000000		DW	TRANS,0000H
AA48 00000000		DW	0000H,0000H
AA4C F0AE54AA		DW	DIRBF,DPBLK
AA50 BEAF8FAF		DW	CHK01,ALL01
;			
; DPBLK ;DISK PARAMETER BLOCK, COMMON TO ALL DISKS			
AA54 2200		DW	34 ;SECTORS PER TRACK
AA56 03		DB	3 ;BLOCK SHIFT FACTOR
AA57 07		DB	7 ;BLOCK MASK
AA58 00		DB	0 ;NULL MASK
AA59 8700		DW	135 ;DISK SIZE-1
AA5B 3F00		DW	63 ;DIRECTORY MAX
AA5D C0		DB	192 ;ALLOC 0
AA5E 00		DB	0 ;ALLOC 1
AA5F 1000		DW	16 ;CHECK SIZE
AA61 0200		DW	2 ;TRACK OFFSET
;			
; END OF FIXED TABLES			
;			
; MEMORY INITIALIZED WHEN BIOS READ IN AT BOOT TIME			
;			
AA63 40	LASTKY:	DB	40H ;VECTOR OF LAST KEY PRESSED
AA64 00	TOGGLE-	DB	00H ;CAPS LOCK HOUSEKEEPING
AA65 00	CSTAT:	DB	00H ;CHARACTER AVAILABLE FLAG
AA66 0000	MSGPTR:	DW	0000H ;MESSAGE POINTER
AA68 00FD	TBLPTR.	DW	0FD00H ;KEYBOARD CODE TABLE

AA6A 00FC	MSGTBL:	DW	0FC00H	;MESSAGE VECTOR TABLE
				;
				MISC. CONSOLE EQUATES
				;
F28D =	SHFTST	EQU	0F28DH	;CONTROL,COMMODORE,SHIFT KEYS
F0CC =	FLASH	EQU	0F0CCH	;CURSOR FLASH ENABLE
F0CF =	CURSOR	EQU	0F0CFH	;CURSOR CHARACTER
				;
				INDIVIDUAL SUBROUTINES TO PERFORM EACH FUNCTION
	BOOT:			
AA6C 3E20		MVI	A,20H	;ASCII SPACE
AA6E 32CFF0		STA	CURSOR	;SET UP CURSOR
AA71 AF		XRA	A	;ZERO IN THE ACCUM
AA72 320300		STA	IOBYTE	;CLEAR THE IOBYTE
AA75 320400		STA	CDISK	;SELECT DISK ZERO
AA78 32EFAE		STA	CURDSK	;CLEAR VIRTUAL DISK POINTER
AA7B 32E1AE		STA	HSTACT	;HOST BUFFER INACTIVE
AA7E 32E3AE		STA	UNACNT	;CLEAR UNALLOC COUNT
AA81 3EC3		MVI	A,0C3H	;C3 IS JUMP OPCODE
AA83 320000		STA	0 + BASE	;FOR JUMP TO WBOOT
AA86 2103AA		LXI	H,WBOOTE	;WBOOT ENTRY POINT
AA89 220100		SHLD	1 + BASE	;SET ADDRESS FIELD
				;
AA8C 320500		STA	5 + BASE	;JUMP TO BDOS OPCODE
AABF 21069C		LXI	H,BDOS	;BDOS ENTRY POINT
AA92 220600		SHLD	6 + BASE	;SET ADDRESS FIELD
				;
AA95 018000		LXI	B,80H + BASE	;DEFAULT DMA ADDRESS
AA98 CD2BAD		CALL	SETDMA	
				;
AA9B 11A6AA		LXI	D,SIGNON	;DE POINTS TO SIGNON MSG
AA9E 0E09		MVI	C,9	;PRINT STRING FUNCTION
AAA0 CD0500		CALL	ENTRY	;GO TO BDOS
AAA3 C3B9AB		JMP	GOCPM1	;GET READY FOR CCP
				;
AAA6 0C0A	SIGNON:	DB	0CH,0AH	;CLEAR SCREEN
AAA8 2020202043		DB	' COMMODORE 64 20K CP/M VERS 2 2'	
AACC 0D0A0A		DB	0DH,0AH,0AH	
AACF 2020436F70		DB	' COPYRIGHT @ 1979, DIGITAL RESEARCH',0DH,0AH	

AAF7 20202020	DB	' COPYRIGHT @ 1982, COMMODORE',0DH,0AH
AB1B 0A24	DB	0AH,'\$' ;END OF STRING MARKER
;		
;		
WBOOT:		
AB1D 318000	LXI	SP,80H + BASE ;USE SPACE BELOW BUFFER FOR STACK
AB20 0E00	MVI	C,0 ;SELECT DISK 0
AB22 CD0CAD	CALL	SELDISK
AB25 AF	XRA	A ;FORCE DRIVE A
AB26 3204F9	STA	DISKNO ;ABSOLUTELY, POSITIVELY
AB29 CD79AE	CALL	CHGDSK ;IF NOT ALREADY SELECTED
AB2C CD02AD	CALL	HOME ;GO TO TRACK 00
AB2F 3E0D	MVI	A,0DH ;CARRIAGE RETURN
AB31 CDAAAC	CALL	COUT5 ;OUTPUT IT
,		
AB34 110094	LXI	D,CCP ;START OF LOAD
AB37 0616	MVI	B,NSECTS
AB39 2601	MVI	H,1 ;TRACK NUMBER
AB3B 2E06	MVI	L,6 ;SECTOR NUMBER
AB3D 7C	LOAD1: MOV	A,H
AB3E 3203F9	STA	TRACK
AB41 7D	MOV	A,L
AB42 3202F9	STA	SECTOR
AB45 3E00	MVI	A,VICRD ;DISK READ COMMAND
AB47 CD90AB	CALL	IO6510
:		
AB4A 3A01F9	LDA	DATA
AB4D B7	ORA	A
AB4E 20ED	J1: DB	JRNZ, (LOAD1-J1-2) AND OFFH
AB50 E5	PUSH	H
AB51 C5	PUSH	B
AB52 010001	LXI	B,256
AB55 2100F8	LXI	H,HSTBUF ;DISK BUFFER
AB58 ED	DB	0EDH ;LDIR INSTRUCTION
AB59 B0	DB	0B0H
AB5A 0E2A	MVI	C,'*' ;SHOW IT'S LOADING
AB5C CD76AC	CALL	CONOUT
AB5F C1	POP	B
AB60 E1	POP	H
AB61 05	DCR	B ;DECREMENT SECTOR COUNT

AB62 280B	J2	DB	JRZ,GOCPM-J2-2	
AB64 2C		INR	L	;NEXT SECTOR
AB65 7D		MOV	A,L	
AB66 FE11		CPI	17	
AB68 38D3	J3:	DB	JRC, (LOAD1-J3-2) AND OFFH	
AB6A 24		INR	H	
AB6B 2E00		MVI	L,0	
AB6D 18CE	J4:	DB	JR, (LOAD1-J4-2) AND OFFH	
			END OF LOAD OPERATION, SET PARAMETERS AND GO TO CP/M	
GOCPM:				
AB6F 3EC3		MVI	A,0C3H	,C3 IS A JMP INSTRUCTION
AB71 320000		STA	0 + BASE	,FOR JMP TO WBOOT
AB74 2103AA		LXI	H,WBOOTE	,WBOOT ENTRY POINT
AB77 220100		SHLD	1 + BASE	;SET ADDRESS FIELD FOR JMP AT 0
AB7A 320500		STA	5 + BASE	;FOR JMP TO BDOS
AB7D 21069C		LXI	H,BDOS	;BDOS ENTRY POINT
AB80 220600		SHLD	6 + BASE	,ADDRESS FIELD OF JUMP AT 5 TO BDOS
AB83 018000		LXI	B,80H + BASE	.DEFAULT DMA ADDRESS IS 80H
AB86 CD2BAD		CALL	SETDMA	
AB89 3A0400	GOCPM1:	LDA	CDISK	;GET CURRENT DISK NUMBER
AB8C 4F		MOV	C,A	;SEND TO THE CCP
AB8D C30094		JMP	CCP	;GO TO CP/M FOR FURTHER PROCESSING
			MAIN ROUTINE TO TRANSFER EXECUTION TO 6510	
AB90 3200F9	IO6510:	STA	CMD	;PUT A IN 6510 COMMAND REGISTER
AB93 3E01		MVI	A,OFF	
AB95 3200CE		STA	MODESW	;TURN OFF Z80
AB98 00		NOP		;REQUIRED BY HARDWARE
AB99 C9		RET		

```

;
CONST      :CONSOLE STATUS, RETURN OFFH IF CHARACTER READY,
            00H IF NOT

AB9A 2A66AA      LHLD      MSGPTR      ,MESSAGE MODE?
AB9D 7C           MOV       A,H
AB9E B5           ORA        L
AB9F 3EFF         MVI       A,OFFH      ;DATA READY FLAG
ABA1 C0           RNZ                ;RETURN IF MSGPTR<>0
;

ABA2 3A65AA      LDA        CSTAT      ,ALREADY A CHAR?
ABA5 A7           ANA        A
ABA6 C0           RNZ                ,YES IF NOT 0
;

ABA7 3E02         MVI       A,VICIN    ,CHECK KEYBOARD COMMAND
ABA9 CD90AB      CALL      IO6510
;

ABAC 3A8DF2      LDA        SHFTST     ,GET STATUS OF CONTROL KEYS
ABAF E602         ANI        02H       ,CHECK FOR COMMODORE KEY
ABB1 2810         J5.        DB        JRZ, CONST0-J5-2 ;JUMPIF NOT PRESSED
;

ABB3 3A64AA      LDA        TOGGLE     ;IS THIS AN UPSTROKE?
ABB6 A7           ANA        A
ABB7 200A         J6.        DB        JRNZ,CONST0-J6-2 ,NO WAITING TO
                                RELEASE
ABB9 3A33AA      LDA        KYBDMD     ;GET CAPS MODE FLAG
ABBC EE01         XRI        01H       ;TOGGLE MODE BIT
ABBE 3233AA      STA        KYBDMD
ABC1 3E01         MVI       A.1
ABC3 3264AA      CONST0: STA        TOGGLE
;

ABC6 3A05F9      LDA        KYCHAR     ,GET SCANNED DATA
ABC9 FE3A         CPI        3AH       ;BAD CONTROL DATA
ABCB 280A         J7:        DB        JRZ,CONST1-J7-2
;

ABCD FE3D         CPI        3DH       ;BAD CONTROL DATA
ABCF 2806         J8.        DB        JRZ,CONST1-J8-2
;

ABD1 2163AA      LXI        H, LASTKY  ;COMPARE WITH PREVIOUS
ABD4 BE           CMP       M          ; SCAN DATA
ABD5 2005         J9:        DB        JRNZ,CONST2-J9-2 ;IF DIFFERENT, NEW KEY

```

ABD7 AF	CONST1:	XRA	A	;DATA NOT READY FLAG
ABD8 3265AA		STA	CSTAT	;SAVE FOR LATER
ABDB C9		RET		
;				
ABDC F5	CONST2:	PUSH	PSW	
ABDD 01F401		LXI	B,500	
ABE0 0B	CONST3:	DCX	B	;DELAY FOR KEYBOUNCE
ABE1 79		MOV	A,C	
ABE2 B0		ORA	B	
ABE3 20FB	J10:	DB	JRNZ,(CONST3-J10-2) AND 0FFH	
;				
ABE5 3E02		MVI	A,VICIN	;GET CHARACTER AGAIN
ABE7 CD90AB		CALL	IO6510	
;				
ABEA F1		POP	PSW	
ABEB 2105F9		LXI	H,KYCHAR	
ABEE BE		CMP	M	
ABEF 20E6	J11:	DB	JRNZ,(CONST1-J11-2) AND 0FFH	;IF<>0, BOUNCING
;				
ABF1 3263AA		STA	LASTKY	;UPDATE LAST KEY
ABF4 FE40		CPI	40H	;IF 40H, NO KEY PRESSED
ABF6 28DF	J12:	DB	IRZ,CONST1-J12-2) AND 0FFH	
;				
ABF8 3EFF		MVI	A,0FFH	;DATA READY FLAG
ABFA 3265AA		STA	CSTAT	;SAVE FOR LATER
ABFD C9		RET		
;				
	CONIN:			;CONSOLE CHARACTER INTO REGISTER A
ABFE 3E00		MVI	A,0	;TURN ON CURSOR
AC00 32CCF0		STA	FLASH	
;				
AC03 2A66AA		LHLD	MSGPTR	;ARE WE IN MESSAGE MODE?
AC06 7C		MOV	A,H	
AC07 B5		ORA	L	
AC08 2044	J13:	DB	JRNZ.CONIN5-J13-2	
;				
;				
AC0A CD9AAB	CONIN1.	CALL	CONST	;CHECK CONSOLE STATUS
AC0D B7		ORA	A	
AC0E 28FA	J14:	DB	JRZ.(CONIN1-J14-2) AND 0FFH	;UNTIL NEW

CHAR

AC10 AF		XRA	A	
AC11 3265AA		STA	CSTAT	;CLEAR CSTAT
AC14 3A33AA	CONIN2	LDA	KYBDM D	;UNSHIFT = 0, CAPS = 1
AC17 47		MOV	B,A	
AC18 3A8DF2		LDA	SHFTST	;GET MODIFIER STATUS
AC1B E601		ANI	01H	;IS A SHIFT KEY DOWN?
AC1D 2802	J15	DB	JRZ,CONIN3-J15-2	;JUMP IF NO
;				
AC1F 0602		MVI	B,2	;SHFIT = 2
AC21 3A8DF2	CONIN3	LDA	SHFTST	;GET MODIFIER STATUS
AC24 E604		ANI	04H	;IS THE CONTROL KEY DOWN?
AC26 2802	J16:	DB	JRZ,CONIN4-J16-2	;JUMP IF NO
;				
AC28 0603		MVI	B,3	;CONTROL = 3
AC2A 3A63AA	CONIN4.	LDA	LASTKY	;GET KEY POSITION
AC2D 87		ADD	A	;*2
AC2E 87		ADD	A	;*4
AC2F 80		ADD	B	;ADD IN OFFSET
AC30 2A68AA		LHLD	TBLPTR	;GET BEGINNING OF KEYTBL
AC33 85		ADD	L	;VECTOR INTO TABLE
AC34 6F		MOV	L,A	
AC35 3E00		MVI	A,0	
AC37 8C		ADC	H	
AC38 67		MOV	H,A	
AC39 7E		MOV	A,M	;GET CHARACTER FROM TABLE
AC3A FE80		CPI	80H	;MESSAGE IF >7FH
AC3C 3820	J17:	DB	JRC,CONIN7-J17-2	;JUMP IF ASCII CHAR
;				
AC3E 2A6AAA		LHLD	MSGTBI	;GET BEGINNING OF MVTBL
AC41 E67F		ANI	7FH	;STRIP OF MESSAGE BIT
AC43 87		ADD	A	;*2
AC44 85		ADD	L	;VECTOR INTO TABLE
AC45 6F		MOV	L,A	
AC46 3E00		MVI	A,0	
AC48 8C		ADC	H	
AC49 67		MOV	H,A	
AC4A 7E		MOV	A,M	;LOW ORDER BYTE
AC4B 23		INX	H	
AC4C 66		MOV	H,M	;HIGH ORDER BYTE

AC4D 6F		MOV	L,A	
AC4E 46	CONIN5:	MOV	B,M	,GET CHARACTER
AC4F 23		INX	H	,CHECK NEXT CHARACTER
AC50 7E		MOV	A,M	
AC51 A7		ANA	A	
AC52 2003	J18:	DB	JRNZ,CONIN6-J18-2	,IF 0, B HAS LAST CHAR
				;
AC54 210000		LXI	H,0000H	,END OF MESSAGE MODE
AC57 2266AA	CONIN6	SHLD	MSGPTR	,SAVE MESSAGE POINTER
AC5A 78		MOV	A,B	,CHECK CHARACTER
AC5B A7		ANA	A	,MAYBE 1ST IS 0
AC5C 28AC	J19:	DB	JRZ,(CONIN1-J19-2) ND 0FFH	,IF<>0, NOT CHAR
				;
AC5E F5	CONIN7:	PUSH	PSW	,SAVE CHARACTER
AC5F 3E01		MVI	A,1	
AC61 32CCF0		STA	FLASH	,TURN OFF CURSOR
AC64 2AD1F0		LHLD	0F0D1H	,
AC67 3AD3F0		LDA	0F0D3H	
AC6A 85		ADD	L	
AC6B 6F		MOV	L A	
AC6C 3EF0		MVI	A,0F0H	
AC6E 8C		ADC	H	
AC6F 67		MOV	H,A	
AC70 7E		MOV	A,M	
AC71 E67F		ANI	07FH	
AC73 77		MOV	M,A	
AC74 F1		POP	PSW	,GET CHARACTER
AC75 C9		RET		,DONE
				;
	CONOUT:			,CONSOLE CHARACTER OUTPUT FROM REGISTER C
AC76 3AFFFC		LDA	IOTYPE	,GET CONFIGURATION BYTE
AC79 E601		ANI	10H	,BIT 4 = 1 TO IGNORE FILTER
AC7B 79		MOV	A,C	,GET TO ACCUMULATOR
AC7C 202C	J20	DB	JRNZ,COUT5-J20-2	,PRINT AS RECEIVED
				;
AC7E CDDAAC		CALL	SWAP	,EXCHANGE UPPER AND LOWER CASE
AC81 FE0C		CPI	0CH	,ASCII CLEAR SCREEN?
AC83 2004	J21:	DB	JRNZ,COUT1-J21-2	,JUMP IF NO
				;
AC85 3E93		MVI	A,93H	,COMMODORE CLEAR SCREEN CMD

AC87 1821	J22:	DB	JR,COUT5-J22-2
	;		
AC89 FE08	COUT1:	CPI	08H ;ASCII BACKSPACE?
AC8B 2004	J23:	DB	JRNZ,COUT2-J23-2 ;JUMP IF NO
	;		
AC8D 3E14		MVI	A,14H ;COMMODORE BACKSPACE CMD
AC8F 1819	J24:	DB	JR,COUT5-J24-2
	;		
AC91 FE0A	COUT2:	CPI	0AH ;LINE FEED?
AC93 2004	J25:	DB	JRNZ,COUT3-J25-2
	;		
AC95 3E11		MVI	A,17 ;COMMODORE LINE FEED
AC97 1811	J26:	DB	JR,COUT5-J26-2
	;		
AC99 FE0D	COUT3:	CPI	0DH ;CARRIAGE RETURN?
AC9B 2007	J27:	DB	JRNZ,COUT4-J27-2
	;		
AC9D CDAAAC		CALL	COUT5
ACA0 3E91		MVI	A,145 ;UP 1 LINE TO NEGATE AUTO LF
ACA2 1806	J28:	DBB	JR,COUT5-J28-2
	;		
ACA4 FE20	COUT4:	CPI	20H
ACA6 D8		RC	;RETURN IF UNDECODED CONTROL CHAR
ACA7 FE80		CPI	80H
ACA9 D0		RNC	;RETURN IF NOT ASCII CHARACTER
	;		
ACAA 3201F9	COUT5	STA	DATA ;PUT DATA IN CHARACTER REGISTER
ACAD 3E03		MVI	A,VICOUT ;SCREEN OUTPUT COMMAND
ACAF 181D	J29:	DB	JR.LIST3-J29-2
	;		
	LIST:		;LIST CHARACTER FROM REGISTER C
ACB1 3AFFFC		LDA	IOTYPE ;WHAT KIND OF PRINTER?
ACB4 E604		ANI	04H ;0 IF 1515, 1 IF 4022
ACB6 79		MOV	A,C ;CHARACTER TO REGISTER A
ACB7 2010	J30:	DB	JRNZ,LIST2-J30-2 ;JUMP IF NO SWAP
	;		
ACB9 3AFFFC		LDA	IOTYPE
ACBC E608		ANI	08H ;WHICH TYPE OF SWAP?

ACBE 79		MOV	A,C	;GET CHARACTER
ACBF 2005	J31:	DB	JRNZ,LIST1-J31-2	
	;			
ACC1 CDDAC		CALL	SWAP	;SWAP UPPER AND LOWER CASE
ACC4 1803	J32:	DB	JR,LIST2-J32-2	
	;			
ACC6 CDEDAC	LIST1:	CALL	SWAP2	;4022 SWAP ROUTINE
ACC9 3201F9	LIST2:	STA	DATA	;PUT DATA IN REGISTER
ACCC 3E05		MVI	A,VICPRT	;ASSUME 1540
ACCE C390AB	LIST3:	JMP	IO6510	
	;			
	LISTST:			;RETURN LIST STATUS (0 IF NOT READY, 1 IF READY)
ACD1 3E04		MVI	A,VICPST	;PRINTER STATUS COMMAND
ACD3 CD90AB		CALL	IO6510	
ACD6 3A01F9		LDA	DATA	;DATA IS STATUS
ACD9 C9		RET		
	;			
	SWAP:			;SWAP UPPER AND LOWER CASE FOR COMMODORE-64
ACDA FE41		CPI	41H	;LESS THAN UC 'A'?
ACDC D8		RC		;RETURN IF SO
	;			
ACDD FE5B		CPI	5BH	;UC LETTER?
ACDF 3809	J33:	DB	JRC,SWAP1-J33-2	;JUMP IF SO
	;			
ACE1 FE61		CPI	61H	;LESS THAT LC 'A'
ACE3 D8		RC		;RETURN IF SO
	;			
ACE4 FE7B		CPI	7BH	;LC LETTER?
ACE6 D0		RNC		;RETURN IF NO
	;			
ACE7 E65F		ANI	5FH	;TURN OFF BIT 5
ACE9 C9		RET		
	;			
ACEA F620	SWAP1:	ORI	20H	;TURN ON BIT 5
ACEC C9		RET		
	;			
ACED FE41	SWAP2:	CPI	41H	;CY IF LESS THAN UC 'A'
ACEF D8		RC		
ACF0 FE60		CPI	60H	;CY IF 40H < A < 60H
ACF2 3003	J34:	DB	JRNC,SWAP3-J34-2	
	;			


```

ACF4 F680          ORI      80H
ACF6 C9           RET

;

ACF7 E65F        SWAP3: ANI      5FH
ACF9 C9           RET

;

PUNCH:           ;PUNCH CHARACTER FROM REGISTER C
ACFA 79          MOV      A,C      ;CHARACTER TO REGISTER A
ACFB 00           NOP
ACFC C9           RET              ;NULL SUBROUTINE

;

;
READER:          ;READ CHARACTER INTO REGISTER A FROM READER
                DEVICE
ACFD 3E1A        MVI      A,1AH    ;ENTER END OF FILE FOR NOW
                                (REPLACE LATER)
ACFF E67F        ANI      7FH      ;REMEMBER TO STRIP PARITY BIT
AD01 C9           RET

;

;
;* * * * *
;*
;*          CP/M TO HOST DISK CONSTANTS
;*
;*
;* * * * *

0400 =          BLKSIZ  EQU      1024    ;CP/M ALLOCATION SIZE
0100 =          HSTSIZ  EQU      256     ;HOST DISK SECTOR SIZE
0011 =          HSTSPT  EQU      17      ;HOST DISK SECTORS/TRK
0002 =          HSTBLK  EQU      HSTSIZ/128 ;CP/M SECTS/HOST BUFF
0022 =          CPMSPT  EQU      HSTBLK * HSTSPT ;CP/M SECTORS/TRACK
0001 =          SECMSK  EQU      HSTBLK-1 ;SECTOR MASK
0001 =          SECSHF  EQU      1       ;LOG2(HSTBLK)

;

;* * * * *
;*
;*          BDOS CONSTANTS ON ENTRY TO WRITE
;*
;*
;* * * * *

0000 =          WRALL   EQU      0       ;WRITE TO ALLOCATED
0001 =          WRDIR   EQU      1       ;WRITE TO DIRECTORY
0002 =          WRUAL   EQU      2       ;WRITE TO UNALLOCATED

```

```

;
; HOME THE SELECTED DISK
HOME:
AD02 3AE2AE LDA HSTWRT ,CHECK FOR PENDING WRITE
AD05 B7 ORA A
AD06 2003 J35. DB JRNZ,HOMED-J35-2
AD08 32E1AE STA HSTACT ,CLEAR HOST ACTIVE FLAG

HOMED:
AD0B C9 RET

;
SELDSK:
;SELECT DISK
AD0C 210000 LXI H,0000H ,ERROR RETURN CODE
AD0F 79 MOV A,C ,SELECTED DISK NUMBER
AD10 32D8AE STA SEKDSK ,SEEK DISK NUMBER
AD13 FE02 CPI 2 ,MUST BE 0-1
AD15 D0 RNC ,NO CARRY IF 2,3, .
AD16 6F MOV L,A ,DISK NUMBER TO HL
AD17 29 DAD H ,MULTIPLY BY 16
AD18 29 DAD H
AD19 29 DAD H
AD1A 29 DAD H
AD1B 1134AA LXI D,DPBASE ,BASE OF PARM BLOCK
AD1E 19 DAD D ,HL = .DPB(CURDSK)
AD1F C9 RET

;
SETTRK:
;SET TRACK GIVEN BY REGISTERS BC
AD20 60 MOV H,B
AD21 69 MOV L,C
AD22 22D9AE SHLD SEKTRK ,TRACK TO SEEK
AD25 C9 RET

;
SETSEC:
;SET SECTOR GIVEN BY REGISTER C
AD26 79 MOV A,C
AD27 32DBAE STA SEKSEC ,SECTOR TO SEEK
AD2A C9 RET

;
SETDMA:
;SET DMA ADDRESS GIVEN BY BC

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```

AD2B 60          MOV    H,B
AD2C 69          MOV    L,C
AD2D 22ECAE      SHLD   DMAADR
AD30 C9          RET

;
SECTRAN.
;TRANSLATE SECTOR NUMBER BC
AD31 60          MOV    H,B
AD32 69          MOV    L,C
AD33 C9          RET

/
;* * * * *
;*
,* THE READ ENTRY POINT TAKES THE PLACE OF
;* THE PREVIOUS BIOS DEFINITION FOR READ.
;*
;* * * * *
READ:
;READ THE SELECTED CP/M SECTOR
AD34 AF          XRA     A
AD35 32E3AE      STA     UNACNT
AD38 3E01        MVI     A,1
AD3A 32EAAE      STA     READOP ;READ OPERATION
AD3D 32E9AE      STA     RSFLAG ;MUST READ DATA
AD40 3E02        MVI     A,WRUAL
AD42 32EBAE      STA     WRTYPE ;TREAT AS UNALLOC
AD45 1864 J36:    DB      JR,RWOPER-J36 -2 ;TO PERFORM THE READ

;
;* * * * *
;*
,* THE WRITE ENTRY POINT TAKES THE PLACE OF
;* THE PREVIOUS BIOS DEFINITION FOR WRITE.
;*
;* * * * *
WRITE:
;WRITE THE SELECTED CP/M SECTOR
AD47 AF          XRA     A ;0 TO ACCUMULATOR
AD48 32EAAE      STA     READOP ;NOT A READ OPERATION
AD4B 79          MOV     A,C ;WRITE TYPE IN C
AD4C 32EBAE      STA     WRTYPE
AD4F FF02        CPI     WRUAL ;WRITE UNALLOCATED?

```

```

AD51 2017      J37:      DB      JRNZ,CHKUNA-J37-2  ;CHECK FOR UNALLOC
;
;      WRITE TO UNALLOCATED, SET PARAMETERS
AD53 3E08      MVI      A,BLKSIZ/128;NEXT UNALLOC RECS
AD55 32E3AE    STA      UNACNT
AD58 3AD8AE    LDA      SEKDSK      ;DISK TO SEEK
AD5B 32E4AE    STA      UNADSK      ;UNADSK = SEKDSK
AD5E 2AD9AE    LHLD     SEKTRK
AD61 22E5AE    SHLD     UNATRK      ;UNATRK = SECTRK
AD64 3ADB AE    LDA      SEKSEC
AD67 32E7AE    STA      UNASEC      ;UNASEC = SEKSEC
;
;
CHKUNA.
;CHECK FOR WRITE TO UNALLOCATED SECTOR
AD6A 3AE3AE    LDA      UNACNT      ;ANY UNALLOC REMAIN?
AD6D B7        ORA      A
AD6E 2833      J38:      DB      JRZ,ALLOC-J38-2  ;SKIP IF NOT
;
;      MORE UNALLOCATED RECORDS REMAIN
AD70 3D        DCR      A          ;UNACNT = UNACNT-1
AD71 32E3AE    STA      UNACNT
AD74 3AD8AE    LDA      SEKDSK      ;SAME DISK?
AD77 21E4AE    LXI      H,UNADSK
AD7A BE        CMP      M          ;SEKDSK = UNADSK?
AD7B 2026      J39:      DB      JRNZ,ALLOC-J39-2  ;SKIP IF NOT
;
;      DISKS ARE THE SAME
AD7D 21E5AE    LXI      H,UNATRK
AD80 CD40AE    CALL     TRKCMP      ;SEKTRK = UNATRK?
AD83 201E      J40:      DB      JRNZ,ALLOC-J40-2  ;SKIP IF NOT
;
;      TRACKS ARE THE SAME
AD85 3ADB AE    LDA      SEKSEC      ;SAME SECTOR?
AD88 21E7AE    LXI      H,UNASEC
AD8B BE        CMP      M          ;SEKSEC = UNASEC?
AD8C 2015      J41:      DB      JRNZ,ALLOC-J41-2  ;SKIP IF NOT
;
;      MATCH, MOVE TO NEXT SECTOR FOR FUTURE REF
AD8E 34        INR      M          ;UNASEC = UNASEC + 1
AD8F 7E        MOV      A,M        ;END OF TRACK?

```

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AD90 FE22          CPI      CPMSPT      ;COUNT CP/M SECTORS
AD92 3809          J42:     DB          JRC,NOOVF-J42-2  ;SKIP IF NO OVERFLOW
;
;
;      OVERFLOW TO NEXT TRACK
AD94 3600          MVI      M,0          ;UNASEC = 0
AD96 2AE5AE        LHLD     UNATRK
AD99 23            INX      H
AD9A 22E5AE        SHLD     UNATRK      ;UNATRK = UNATRK + 1
;
NOOVF;
;MATCH FOUND, MARK AS UNNECESSARY READ
AD9D AF            XRA      A            ;0 TO ACCUMULATOR
AD9E 32E9AE        STA      RSFLAG      ;RSFLAG = 0
ADA1 1808          J43:     DB          JR,RWOPER-J43-2  ;TO PERFORM THE WRITE
;
ALLOC:
;NOT AN UNALLOCATED RECORD, REQUIRES PRE-READ
ADA3 AF            XRA      A            ;0 TO ACCUM
ADA4 32E3AE        STA      UNACNT      ;UNACNT = 0
ADA7 3C            INR      A            ;1 TO ACCUM
ADA8 32E9AE        STA      RSFLAG      ;RSFLAG = 1
;
; * * * * *
; *
; *      COMMON CODE FOR READ AND WRITE FOLLOWS
; *
; * * * * *
RWOPER:
;ENTER HERE TO PERFORM THE READ/WRITE
ADAB AF            XRA      A            ;ZERO TO ACCUM
ADAC 32E8AE        STA      ERFLAG      ;NOERRORS (YET)
ADAF 3ADB AE       LDA      SEKSEC      ;COMPUTE HOST SECTOR
ADB2 B7            ORA      A            ;CARRY = 0
ADB3 1F            RAR                      ;SHIFT RIGHT
ADB4 32E0AE        STA      SEKHST      ;HOST SECTOR TO SEEK
;
;
;      ACTIVE HOST SECTOR?
ADB7 21E1AE        LXI      H,HSTACT    ;HOST ACTIVE FLAG
ADBA 7E            MOV      A,M
ADBB 3601          MVI      M,1          ;ALWAYS BECOMES 1
ADBD B7            ORA      A            ;WAS IT ALREADY?

```

ADBE 2821	J44:	DB	JRZ,FILHST-J44-2 ;FILL HOST IF NOT
	;		
	;		HOST BUFFER ACTIVE, SAME AS SEEK BUFFER?
ADC0 3AD8AE		LDA	SEKDSK
ADC3 21DCAE		LXI	H,HSTDSK ;SAME DISK?
ADC6 BE		CMP	M ;SEKDSK = HSTDSK?
ADC7 2011	J45:	DB	JRNZ,NOMTCH-J45-2
	;		
	;		SAME DISK, SAME TRACK?
ADC9 21DDAE		LXI	H,HSTTRK
ADCC CD40AE		CALL	TRKCMP ;SEKTRK = HSTTRK?
ADCF 2009	J46:	DB	JRNZ,NOMTCH-J46-2
	;		
	;		SAME DISK, SAME TRACK, SAME BUFFER?
ADD1 3AE0AE		LDA	SEKHST
ADD4 21DFAE		LXI	H,HSTSEC ;SEKHST = HSTSEC?
ADD7 BE		CMP	M
ADD8 2824	J47:	DB	JRZ,MATCH-J47-2 ;SKIP IF MATCH
	;		
	NOMTCH.		
			;PROPER DISK, BUT NOT CORRECT SECTOR
ADDA 3AE2AE		LDA	HSTWRT ;HOST WRITTEN?
ADDD B7		ORA	A
ADDE C44CAE		CNZ	WRHST ;CLEAR HOST BUFF
	;		
	FILHST:		
			;MAY HAVE TO FILL THE HOST BUFFER
ADE1 3AD8AE		LDA	SEKDSK
ADE4 32DCAE		STA	HSTDSK
ADE7 2AD9AE		LHLD	SEKTRK
ADEA 22DDAE		SHLD	HSTTRK
ADED 3AE0AE		LDA	SEKHST
ADF0 32DFAE		STA	HSTSEC
ADF3 3AE9AE		LDA	RSFLAG ;NEED TO READ?
ADF6 B7		ORA	A
ADF7 C49DAE		CNZ	RDHST ;YES, IN 1
ADF8 DFA AF		XRA	A ;0 TO ACCUM
ADFB 32E2AE		STA	HSTWRT ;NO PENDING WRITE
	;		
	MATCH:		
			;COPY DATA TO OR FROM BUFFER

ADFE 3ADB AE		LDA	SEKSEC	;MASK BUFFER NUMBER
AE01 E601		ANI	SECMSK	;LEAST SIGNIF BITS
AE03 6F		MOV	L,A	;READY TO SHIFT
AE04 2600		MVI	H,0	;DOUBLE COUNT
AE06 29		DAD	H	;SHIFT LEFT 7
AE07 29		DAD	H	
AE08 29		DAD	H	
AE09 29		DAD	H	
AE0A 29		DAD	H	
AE0B 29		DAD	H	
AE0C 29		DAD	H	
	;			HL HAS RELATIVE HOST BUFFER ADDRESS
AE0D 1100F8		LXI	D,HSTBUF	
AE10 19		DAD	D	;HL = HOST ADDRESS
AE11 EB		XCHG		;NOW IN DE
AE12 2AECAE		LHLD	DMAADR	;GET/PUT CP/M DATA
AE15 0E80		MVI	C,128	;LENGTH OF MOVE
AE17 3AEAAE		LDA	READOP	;WHICH WAY?
AE1A B7		ORA	A	
AE1B 2006	J48:	DB	JRNZ,RWMOVE-J48-2	;SKIP IF READ
	;			
	;			WRITE OPERATION, MARK AND SWITCH DIRECTION
AE1D 3E01		MVI	A,1	
AE1F 32E2AE		STA	HSTWRT	;HSTWRT = 1
AE22 EB		XCHG		;SOURCE/DEST SWAP
	;			
				RWMOVE.
				,C INITIALLY 128, DE IS SOURCE, HL IS DEST
AE23 1A		LDAX	D	;SOURCE CHARACTER
AE24 13		INX	D	
AE25 77		MOV	M,A	;TO DEST
AE26 23		INX	H	
AE27 0D		DCR	C	;LOOP 128 TIMES
AE28 20F9	J49:	DB	JRNZ,(RWMOVE-J49-2) AND 0FFH	
	;			
	;			DATA HAS BEEN MOVED TO/FROM HOST BUFFER
AE2A 3AEBAE		LDA	WRTYPE	;WRITE TYPE
AE2D FE01		CPI	WRDIR	;TO DIRECTORY?
AE2F 3AE8AE		LDA	ERFLAG	;IN CASE OF ERRORS
AE32 C0		RNZ		;NO FURTHER PROCESSING
	;			
	;			CLEAR HOST BUFFER FOR DIRECTORY WRITE

AE33 B7	ORA	A	;ERRORS?
AE34 C0	RNZ		;SKIP IF SO
AE35 AF	XRA	A	,0 TO ACCUM
AE36 32E2AE	STA	HSTWRT	;BUFFER WRITTEN
AE39 CD4CAE	CALL	WRHST	
AE3C 3AE8AE	LDA	ERFLAG	
AE3F C9	RET		
;			
;* * * * *			
;* *			
;* UTILITY SUBROUTINE FOR 16-BIT COMPARE *			
;* *			
;* * * * *			
TRKCMP:			
	,HL = .UNATRK OR .HSTTRK, COMPARE WITH SEKTRK		
AE40 EB	XCHG		
AE41 21D9AE	LXI	H,SEKTRK	
AE44 1A	LDAX	D	;LOW BYTE COMPARE
AE45 BE	CMP	M	;SAME?
AE46 C0	RNZ		;RETURN IF NOT
	LOW BYTES EQUAL, TEST HIGH 1S		
AE47 13	INX	D	
AE48 23	INX	H	
AE49 1A	LDAX	D	
AE4A BE	CMP	M	;SETS FLAGS
AE4B C9	RET		
;			
;* * * * *			
;* *			
;* WRHST PERFORMS THE PHYSICAL WRITE TO *			
;* THE HOST DISK, RDHST READS THE PHYSICAL *			
;* DISK. *			
;* *			
;* * * * *			
WRHST:			
	;HSTDSK = HOST DISK #, HSTTRK = HOST TRACK #,		
	;HSTSEC = HOST SECT #. WRITE "HSTSIZ" BYTES		
	;FROM HSTBUF AND RETURN ERROR FLAG IN ERFLAG.		
	,RETURN ERFLAG NON-ZERO IF ERROR		
AE4C 3E01	MVI	A,VICWR	;LOAD DISK WRITE COMMAND
AE4E 32EEAE	WRHSTO: STA	RW	;PUT COMMAND IN REGISTER

AE51 3ADCAE		LDA	HSTSDK	;GET HOST DISK NUMBER
AE54 3204F9		STA	DISKNO	; AND PUT IN COMMON AREA
AE57 CD79AE		CALL	CHGDSK	;CORRECT VIRTUAL DISK?
AE5A 3ADDAE	WRHST2:	LDA	HSTTRK	;GET HOST TRACK NUMBER
AE5D 3C		INR	A	;ADD 1 FOR VIC OFFSET
AE5E FE12		CPI	18	;WE WANT TO SKIP TRACK 18
AE60 3801	J50:	DB	JRC,WRHST3-J50-2	;CARRY IF TRACK<18
AE62 3C		INR	A	
AE63 3203F9	WRHST3:	STA	TRACK	;PUT IN COMMON AREA
AE66 3ADFAE		LDA	HSTSEC	;GET HOST SECTOR NUMBER
AE69 3202F9		STA	SECTOR	;PUT IN COMMON AREA
AE6C 3AEAE		LDA	RW	;GET DISK COMMAND
AE6F CD90AB		CALL	IO6510	
AE72 3A01F9		LDA	DATA	;GET DISK STATUS
AE75 32E8AE		STA	ERFLAG	; AND STORE IN ERFLAG
AE78 C9		RET		
;				
AE79 67	CHGDSK:	MOV	H,A	;SAVE DISK NUMBER
AE7A 3AFFFC		LDA	IOTYPE	;BIT 0 = 0 FOR VIRTUAL
AE7D E601		ANI	01	
AE7F C0		RNZ		;NOT ZERO IF 2 DRIVES
AE80 3204F9		STA	DISKNO	;FORCE DRIVE A
AE83 7C		MOV	A,H	;RESTORE DISK NUMBER
;				
AE84 21EFAE		LXI	H,CURDSK	;IS THIS OUR CURRENT DISK?
AE87 BE		CMP	M	
AE88 C8		RZ		;RETURN IF OK
;				
AE89 77		MOV	M,A	;SET UP NEW DISK
AE8A C641		ADI	'A'	;FORM ASCII DRIVE LETTER
AE8C 32AFAE		STA	DSKMNT	;PUT IN MESSAGE
;				
AE8F 21A1AE		LXI	H,MNTMSG	;INSERT DISK MESSAGE
AE92 CDCCAE		CALL	PMSG	;GO PRINT IT
AE95 CDFEAB	CHGD1:	CALL	CONIN	.WAIT FOR RETURN
AE98 FE0D		CPI	0DH	
AE9A 20F9	J51:	DB	JRNZ,(CHGD1-J51-2) AND 0FFH	
AE9C C9		RET		
;				
RDHST:				

;HSTSDK = HOST DISK #, HSTTRK = HOST TRACK #,
;HSTSEC = HOST SECT #. READ "HSHSIZ" BYTES

```

;INTO HSTBUF AND RETURN ERROR FLAG IN ERFLAG.
AE9D 3E00      MVI      A,VICRD      ;DISK READ COMMAND
AE9F 18AD      J52       DB          JR,(WRHST0-J52-2) AND OFFH  ;REST LIKE
                                         WRITE

,
AEA1 0D0A496E73 MNTMSG: DB          0DH,0AH,'INSERT DISK'
AEAF 41        DSKMNT: DB          'A'
AEB0 20696E746F      DB          ' INTO DRIVE 0, PRESS RETURN'
AECB 00        DB          00H

,
AECC 7E        PMSG:   MOV      A,M
AECD A7        ANA      A
AECE C8        RZ
AECF E5        PUSH    H
AED0 4F        MOV      C,A
AED1 CD76AC     CALL    CONOUT
AED4 E1        POP      H
AED5 23        INX      H
AED6 18F4      J53-     DB          JR,(PMSG-J53-2) AND OFFH

;
; * * * * *
; *
; *
; *      UNINITIALIZED RAM DATA AREAS
; *
; *
; *
; * * * * *

AED8          SEKDSK: DS      1          ;SEEK DISK NUMBER
AED9          SEKTRK: DS      2          ;SEEK TRACK NUMBER
AEDB          SEKSEC: DS      1          ;SEEK SECTOR NUMBER

;

AEDC          HSTDSK: DS      1          ;HOST DISK NUMBER
AEDD          HSTTRK: DS      2          ;HOST TRACK NUMBER
AEDF          HSTSEC: DS      1          ;HOST SECTOR NUMBER

;

AEE0          SEKHST: DS      1          ;SEEK SHR SECSHF
AEE1          HSTACT: DS      1          ;HOST ACTIVE FLAG
AEE2          HSTWRT: DS      1          ;HOST WRITTEN FLAG

,
AEE3          UNACNT: DS      1          ;UNALLOC REC CNT
AEE4          UNADSK: DS      1          ;LAST UNALLOC DISK
AEE5          UNATRK: DS      2          ;LAST UNALLOC TRACK

```

AEE7	UNASEC:	DS	1	,LAST UNALLOC SECTOR
				;
AEE8	ERFLAG:	DS	1	,ERROR REPORTING
AEE9	RSFLAG:	DS	1	,READ SECTOR FLAG
AEEA	READOP	DS	1	;1 IF READ OPERATION
AEEB	WRTYPE:	DS	1	;WRITE OPERATION TYPE
AEEC	DMAADR:	DS	2	;LAST DMA ADDRESS
AEEE	RW:	DS	1	,TEMPORARY COMMAND REGISTER
AEFF	CURDSK:	DS	1	;VIRTUAL DISK POINTER
				;
				, SCRATCH RAM AREA FOR BDOS USE
AEF0 =	BEGDAT	EQU	\$	'BEGINNING OF DATA AREA
AEF0	DIRBF:	DS	128	;SCRATCH DIRECTORY AREA
AF70	ALL00:	DS	31	;ALLOCATION VECTOR 0
AF8F	ALL01:	DS	31	;ALLOCATION VECTOR 1
AFAE	CHK00:	DS	16	,CHECK VECTOR 0
AFBE	CHK01:	DS	16	;CHECK VECTOR 1
				;
AFCE =	ENDDAT	EQU	\$;END OF DATA AREA
00DE =	DATSIZ	EQU	\$-BEGDAT	;SIZE OF DATA AREA
AFCE			END	

ABOUT THE COMMODORE 64 CP/M® OPERATING SYSTEM USER'S GUIDE...

The Commodore Z80 microprocessor and CP/M® operating system let you turn your Commodore 64 into a dual processor home microcomputer.

CP/M® lets you use more than 15,000 CP/M® application programs. CP/M® software includes widely used business applications such as financial reporting and analysis, investment planning, word processing, farm and restaurant management, data base, exotic language compilers, and much, much more.

The *Commodore 64 CP/M® Operating System User's Guide* tells you how to use the Z80 cartridge and the CP/M® operating system. This manual gives you detailed information on how to bring up CP/M® on your system. We also give you a detailed reference section with descriptions of all the CP/M® commands and utility programs.

For the beginner, this manual offers simple, step-by-step instructions with all the information you need to use CP/M® on your Commodore 64.

For the advanced user, this manual provides detailed information on the technical workings of CP/M® on your Commodore 64 and the engineering details of your Z80 cartridge.

This manual is written in an easy-to-read style and is designed to help you get the most out of the Z80 microprocessor and the CP/M® operating system.



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